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INFORMATION CIRCULAR

BARITE AND BARIUM PRODUCTS

PART I - GENERAL INFORMATION

BY

R. M. SANTMYERS

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January, 1930.

INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

BARITE AND BARIUM PRODUCTS[1]

PART I. BARITE.

By R. M. Santmyers[2]

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DESCRIPTION AND USES

The element barium occurs in nature as the minerals barite (barium sulphate, $BaSO_4$) and witherite (barium carbonate, $BaCO_3$). The chemical compounds manufactured from these two minerals constitute an important class of commercial products, the use of which in certain cases has been increasing steadily during recent years.

Barite, sometimes called "barytes," "heavy spar," "cawk," or "tiff," when pure contains 65.7 per cent of barium oxide or "baryta" (BaO) and 34.3 per cent of sulphur trioxide (SO_3). Much of the crude barite ore mined contains impurities, notably sulphate or carbonate of lime, silica, alumina, calcium fluoride, and strontium sulphate. In addition, sulphide minerals, such as galena, chalcopyrite, sphalerite, and pyrite, may also be present. Most of the barite mined in the United States has some iron in the form of oxides as a coating on the surfaces of the lumps or crystals and in cracks and cleavages in the mineral.

Commercial crude barite should carry more than 93 per cent barium sulphate; the better grades of domestic barite carry at least 95 per cent. Ore running less than 90 per cent barium sulphate is not commonly acceptable to the lithopone and barium chemical manufacturers, who specify also a low maximum content of iron and other impurities. Certain of the users of crude barite impose penalties of so much per unit for each percentage below a stipulated grade.

Barite is a heavy, white, opaque or translucent mineral. The specific gravity of the material is about 4.5 and identifies it as one of the heaviest of the nonmetallic minerals. It varies somewhat in hardness, the average being 3, or about the same as the hardness of calcite. It is frequently to be found in well-developed crystals, which vary considerably in their appearance and habit. They possess a perfect cleavage parallel to the base, and perpendicular to the base are two prismatic cleavages parallel to the faces of the primitive rhombic prism. With these three directions of perfect cleavage, massive barite sometimes presents a certain resemblance to calcite. The angles between the cleavages are different, however; and further, barite may be readily distinguished from calcite by its heaviness, and from both calcite and witherite by not effervescing with acid.

In the trade two types of crude barite are recognized, the "hard crystalline" variety and the "soft" variety. The former has a glossy appearance and can not be broken in the hand, whereas the soft variety has a milky appearance and can be easily crumbled. The soft type is preferred by the grinders because, on account of its texture, produces the highest grade of ground barite and because the impurities are generally such as can be easily dissolved and eliminated by an acid bath. This grade causes less wear on the grinding machinery, and is said to roast better than the hard variety. The hard variety can be used to better advantage in the lithopone and barium chemical industries than in the manufacture of ground barite.

The commercial application of barite, as such, is largely dependent on the fact that it is a heavy, white mineral, chemically inert, and comparatively cheap. The market price of crude barite depends to a large extent on the ease

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with which it can be ground, and the price of ground barite depends on color, fineness of grinding, and, to some extent, on its chemical purity.

Barite enters into commerce in the following forms:

1. Crude barite, or tiff, is sold as it comes from the ground, except as it may have to be washed and jigged to remove earthy and mineral impurities. It is the raw material for the manufacture of ground barite, barium chemicals, and lithopone.

2. Ground barite is the crude ore which has been washed and jigged and then ground very fine. If the natural mineral is of the desired degree of whiteness, which it rarely is in the United States, no treatment other than grinding is necessary; otherwise it may be bleached with sulphuric acid. Ground barite which is not pure white may be sold as ground barite "off color" or "unbleached;" this grade is used for dark-colored paints. Ground barite of suitable color is used by the paper industry as a filler chiefly in the manufacture of heavy, stiff materials such as playing cards and Bristol board; it is known in the trade as "prime white" or "floated" barite, and is used as a pigment in white paints, or as a filler in paper, linoleum, rubber goods and artificial ivory, and for other purposes where a white, inert pigment or filler is desired. Among its minor uses may be mentioned its employment for X-ray protection, for which it is mixed with rubber to form the hard-rubber casing over the X-ray bulb; it is also introduced into a plaster applied to the walls and ceilings in X-ray rooms. Some ground barite is used in certain types of storage batteries, and as a flux in the smelting of brass. Several glass manufacturers are experimenting with ground barite in the making of glassware, particularly bottles for preserved fruit and vegetables. "Baroid," a special form of ground barium sulphate, is used to seal off gases in the drilling of oil wells and thus prevent "blow-offs."

MISCELLANEOUS USES OF BARITE

Artificial marble	Insulating materials (X-ray)	Shade cloth and other textiles
Asbestos products	Phonograph records	Soap
Colors (lakes)	Printers' ink	Tiles and ceramics, etc
Explosives	Sealing wax	Titanium pigments
Fireworks		

Blanc fixe is precipitated barium sulphate produced by treating a solution of a barium salt with sodium sulphate (salt cake). This product, while having the same chemical composition, is different in physical properties from ground barite. (See under barium chemicals. Part II, Barium Products).

Barite is the only domestic source of barium products. However, a small quantity of witherite is imported for use in the manufacture of barium chemicals. Witherite is a naturally occurring mineral composed chiefly of barium carbonate ($BaCO_3$). When pure it contains 77.6 per cent of barium oxide. Witherite has about the same hardness and specific gravity as barite, but since it is easily decomposed by acids it has advantages over barite in the manufacture of certain chemicals. It is also used to a limited extent as an inert filler in

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rubber. In the United States large quantities of precipitated barium carbonate are manufactured and used to replace the natural barium carbonate or witherite for the manufacture of certain barium chemicals.

3. Barium chemicals are manufactured either direct from crude barite or from ground barite, which may be either barite, (barium sulphate), or witherite, (barium carbonate). Among the more important chemicals are the following: Blanc fixe, or artificial barium sulphate, barium carbonate, barium chloride, barium nitrate, barium monoxide, barium hydroxide, barium dioxide (binoxide, or peroxide), barium sulphide, barium chromate, and barium chlorate.

Barium chemicals will be discussed in Part II of this series under "Barium Products."

HISTORY

The name "barote," from the Greek word meaning "heavy," was given to the mineral known as heavy spar (terva ponderosa) by Guyton de Morveau in 1779. The name itself, afterwards altered to "baryta" by Lavoisier, is indicative of the great density of the mineral. Inasmuch as it is chemically inert, its qualities fitted it admirably for its first and principal use, that of an adulterant. This use brought the mineral into disrepute, and in some countries acts were passed which made it a felony to adulterate certain food products with ground barite. As its properties became better known it began to be looked upon as an important mineral, and considerable quantities entered into commerce.

With its use in the manufacture of lithopone and certain barium chemicals, the production of barite grew rapidly, and as new uses were found for it, certain countries, in which the deposits were rather extensive, began to be looked upon as the principal source of this mineral.

United States, Germany, and England, in order named, are the most important producers of barite today. The character of the deposits and the purity of German barite placed that country in a dominant position as a source of world supply. As a result there was a profound dislocation in the industry during the World War. In the United States, prior to the war, consumers along the Atlantic seaboard obtained their supplies principally from Germany. Missouri was the leading center of domestic production, but sales were largely to consuming points in the interior of the country. Following the outbreak of the war, imports dropped off sharply, and Georgia, due to its close proximity to the leading consumers, forged ahead, producing in 1917 about twice as much barite as Missouri, or 111,300 short tons as compared with 59,046 tons in the latter State.

Barite mining in the United States probably began about 1845, when a few hundred tons of ore was mined in Prince William County, Va. Mining operations in Campbell and Pittsylvania Counties in the Piedmont region, and near Marion, Smyth County, in the Valley region of Virginia, were begun about 1865, and in 1890 the mining and milling of barite on a commercial scale began in Tazewell and Russell Counties.

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In Missouri the first production of barite probably dates back to about 1860,[3] but the occurrence of barite was known long before that date; it was encountered in the lead mines in Washington County and mentioned by several writers. As the State reported an output of 8,000 tons in 1882, it may be assumed that the industry must have been well under way in the seventies.

Production of barite on a commercial scale started in Kentucky about 1903, in Alabama about 1906, and in Georgia and Nevada about 1907.

Today the production of barite comes from only a few States: California, Georgia, Missouri, Nevada, Tennessee, South Carolina, Virginia, and Wisconsin.

MODE OF OCCURRENCE

Barite is a common gangue mineral occurring in ore veins formed at intermediate and shallow depths. It is rarely present at great depths or in contact metamorphic deposits, and in pegmatites. Igneous rocks commonly contain barium in the form of a silicate molecule in feld-spars. Nearly all the barite produced in the United States, however, especially in the eastern and central fields, is associated with weathered limestones and dolomites. Barium sulphate is present in appreciable amounts in many limestones, and since it is almost insoluble it collects with clay and iron oxide in the residual mantle as the limestone weathers away.

The barite deposits in Missouri, Georgia, Kentucky, Virginia, and Tennessee, yielding by far the larger portion of this mineral in the United States, are all associated with sedimentary rocks, chiefly clays representing a disintegration of limestone and dolomite.

The western deposits, on the other hand, especially those in California, are predominantly vein deposits.

GEOGRAPHICAL DISTRIBUTION

DESCRIPTION OF DOMESTIC DEPOSITS

Prior to the World War about 65 per cent of the domestic output of crude barite was mined in the State of Missouri, as previously noted. War-time conditions wrought marked changes in the domestic industry. In 1915 the production of Missouri was almost equaled by that of Georgia, which in 1916 became the chief producing State, with an output nearly twice that of Missouri, although the production of Missouri had almost doubled (see Table 3 and fig. 2). The shifting of the greatest production of crude barite from Missouri to Georgia was due to the cessation of imports of barite and barium chemicals from Germany, lower freight rates to eastern factories making lithopone and barium chemicals, and the geological character of the deposits which permitted mining by means of steam shovels.

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3 - Weigel, W. M., The Barite Industry in Missouri. Tech. Pub. 201, Am. Inst. Min. and Met. Eng., 1929, pp. 1-26.

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War developments, although greatly increasing the output and consumption of crude barite in this country, left the industry divided between two distinct localities: (1) The middle western district, with Missouri as the chief producer, and (2) the southern or Appalachian district, represented chiefly by Georgia and Tennessee. The Missouri deposits may be divided into two districts, the Washington County, or southern field, and the central field embracing Miller and Morgan Counties and parts of several others. The Appalachian district includes, in addition to Georgia and Tennessee, portions of Virginia and North and South Carolina. Considerable barite has been found also in the Cumberland Valley in southern Pennsylvania, although little has been produced there.

Missouri

Barite is found in veins, solution cavities, and residual deposits, but by far the most important occurrences of the mineral in Missouri are in the latter form. These deposits are found in two regions - in southeastern or Washington County district, and in the central district, in the central part of the State, which includes Miller and Morgan Counties and parts of several others. Although the central district embraces a much larger territory than the southeastern, the deposits are widely scattered and the actual production is considerably less than that of Washington County.

The barite in the residual deposits occurs as loose fragments embedded in and scattered through clay. The clay is mostly disintegrated limestone and dolomite.

Of the Washington County district, W. M. Weigel says:[4]

> "The barite fragments vary in size from fines or slimes to masses weighing 200 lbs. or more. Generally the larger masses are near the bottom of the deposit, sometimes on bed rock with fragments of this or overlying strata, but this is not always the case. The clay is very fine, plastic and almost free of grit, and varies from light to very dark red. A deep brownish red is the most common color.
>
> In the Washington County district residual deposits occur in the clay mantle over the top and slopes of the hills. Sometimes a continuous area of over 100 acres will be ore-bearing, with a thickness varying from 4 to 30 ft. Barite is seldom found in the valleys; the richest areas are usually on the gentle slopes part way down the hill; the tops of the hills are inclined to be lean. In some areas the barite may be quite uniformly distributed in the clay, but more often it occurs in concentrated layers with lean beds of clay intervening; it is usually more concentrated in leads or runs, which may be 10 to 20 ft. wide and several hundred feet long. They have no definite relation with the slope of the hill.
>
> One form of concentration in layers shows the following section, which is typical of an area near Cadet, Washington County:

4 - Work cited, p. 6.

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Surface soil	1 ft. to 1 ft. 6 in.
Chert, gravel and clay	1 ft. 6 in. to 2 ft.
Clay, barite, chert and quartz, barite in small fragments, not over 2 in.	2 ft. 6 in. to 4 ft.
Practically barren dark red clay	3 ft. to 4 ft.
Red clay, large chert, and dolomite boulders and large masses of barite, sometimes in almost continuous sheets 4 to 6 in. thick and several square feet in horizontal extent	1 ft. to 2 ft. 6 in.
Red clay, practically barren, depth to bed rock not exposed	

The barite content of the workable deposits varies considerably. In small areas and pockets it may run as high as 20 to 25 per cent. Large areas being mined by steam shovel will probably average under 10 per cent, and considerable areas have been mined which probably yielded less than 5 per cent."

Residual deposits are the most predominant in the central district, and are markedly similar to those in Washington County in that the barite occurs scattered through residual beds or pockets of red clay resulting from the decay and weathering of the overlying rocks. They differ, however, states W. M. Weigle,[5] in that:

"The individual deposits are much smaller in horizontal dimensions, although often considerably deeper. Very few deposits have a horizontal dimension greater than 200 ft. This is probably because in this district the hillsides on which the deposits are found are steeper and the topography in general more rugged. Rim rock is always found on the upper side of the deposit on a slope, and usually at the ends. In all cases the longer axis of the pocket lies parallel to the crest of the hill.

Some of the deposits have been opened to a depth of 50 ft. below the surface, but 15 to 20 ft. is more common. The barite content is higher than in the Washington County district. Many deposits contain 20 per cent or more barite and some old dumps were observed that would contain 12 to 15 per cent barite, from which the larger pieces, 2 in. or over, had been picked by hand.

The barite occurs in smaller fragments than in Washington County; in some deposits there is a large percentage of "glass tiff," a local name for the transparent crystalline form of barite. The iron content is lower and the larger

5 - Ibid.

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pieces do not have the limonite-lined cavities characteristic of much of the barite occurring in large lump form in the Washington County district. The associated clay is much the same in texture and appearance. Drusy quartz is lacking, but there is considerable chert, chert gravel and fragments of hard dolomite, sandstone, and some calcite."

Georgia

The principal barite deposits of Georgia are in the vicinity of Cartersville, Bartow County, though formerly some high-grade barite was mined near Elton, in Murray County. Near Cartersville the barite deposits are closely associated with the Weisner quartzite and the overlying Beaver shaly limestone, which are the two lower formations of the Cambrian rocks. Both formations are intensely folded and faulted, and as a consequence conditions have been favorable to the deposition of minerals, the chief of which are iron ore, ocher, and barite. The barite in the Cartersville district is found with ocher in fractures and cavities in the Weisner quartzite, and as masses and nodules embedded in the residual clays derived from the weathering of both the Weisner and Beaver formations. The residual deposits in Georgia, as in Missouri, are the more important commercially. The principal deposits of the residual type so far worked are east of Cartersville, on both sides of the Etowah River.

In general, bodies of iron ore rest directly on the quartzite at the contact with the overlying Beaver limestone. Down the slope, but parallel to the contact, are found the bodies of residual barite. There is a sharply defined line between the bodies of residual barite and of limonites. It seems probable that the two minerals have replaced distinct beds of the shaly limestone overlying the quartzite and that their present position is largely determined by the specific gravity of the minerals. In the barite-bearing residual clay the barite is said to constitute about one-third of the total material.

Tennessee

The commercially important barite deposits of Tennessee are located in the Sweetwater district, which covers parts of McMinn, Monroe, and London Counties. In this region the pronounced topographical features are the northeastward-trending ridges of Cambrian, Ordovician, and Silurian rocks. These rocks are much folded and further complicated in structure by thrust faulting. The barite deposits are of the residual type; the mineral is found mainly in clays derived from the weathering of dolomite. These clays may be 60 feet thick, but the average thickness is between 10 and 20 feet. The deposits are worked largely by open-cuts on the sides or tops of hills, but few cuts have reached the underlying limestone formations. Much of the barite mined in this district is of the hard, crystalline variety, but some is soft. Most of it is iron-stained, and in some of the deposits the surface of the lumps of barite is coated with one-sixteenth to one-eighth inch of hard limonite. Chert, some of which at first glance closely resembles barite, is abundant in all the deposits, but presents no difficulty in removal.

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Analyses of typical samples published first by Grasty[6] are given below:

Analyses of barite from Tennessee

	Roy property	Terry property
$BaSO_4$	97.56	94.12
Fe_2O_5	.42	.70
SiO_2	.41	2.45

The French Broad district of Cocke and Sevier Counties, on the North Carolina line, has not been extensively developed, as it has limited transportation facilities. The center of the district is about 40 miles east-southeast of Knoxville. In this district veins of barite from 1 to 6 feet wide occur in the Cambrian Cochran conglomerate. They are said to be similar to the veins worked in the past at Stackhouse, N. C., and to carry almost no impurities.

Barite deposits occurring in other localities of the State are not believed to be of commercial importance.

Virginia

There are three types of barite deposits in Virginia. The most important commercially are the deposits in the Piedmont region of Campbell, Pittsylvania, and Bedford Counties and those in the Valley region of Russell, Smyth, and Tazewell Counties. In the Piedmont deposits are also known to exist in Louisa and Prince William Counties.

Of recent importance are the deposits in Fauquier and Prince William Counties which occur in red limestone and shale and in crystalline rocks. The barite occurs as the cement of brecciated zones 4 to 8 feet wide, is of good quality, of the soft variety, and is fairly clean.

A large part of the Virginia output in the last few years has been from residual deposits in Campbell and Pittsylvania Counties which have been derived from the weathering of Cambrian and pre-Cambrian crystalline rocks including schists, quartzites, and limestone. The barite seems to have replaced certain beds of crystalline limestone, as the deposits are associated with that rock. Iron and manganese oxides are found in the clays, and some deposits have produced ocher and umber pigments as well as barite. In a few places manganese ores have also been mined.

In the Valley region barite is found principally in clays derived from the Knox dolomite. It is, however, found in veins and replacement deposits in the unaltered limestone, where it is accompanied by sphalerite, galena, pyrite, and fluorite. The principal mining localities are near Marion, Smyth County; and North Taxewell, Honaker, and Lebanon, in Tazewell and Russell Counties. In the

6 - Grasty, J. S., Barite Deposits of Tennessee. The Tradesman, May 1, 1913, pp. 36-37.

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last two counties there is a continuous belt of barite-bearing ground about 30 miles long extending in a northeasterly direction from Lebanon, Russell County, to a point near North Tazewell, in Tazewell County. The residual barite is practically free from impurities.

South Carolina

The only commercial deposit of barite in South Carolina from which the mineral has been mined in any quantity, is at Kings Creek, Cherokee County. This deposit is on the strike of the deposits in North Carolina on the Kings Mountain Ridge. The deposits occur with sericite schists, and are in the form of lenticular veins approximately parallel to the folded structure. Interlacing and cross veinlets are seen. The veins attain a maximum width of 8 feet, but average about 18 inches. Deposits from which it would appear that a considerable quantity of barite could be easily mined have been opened along the Southern Railway tracks. The barite is granular, white to rose-pink in color, and contains some quartz and a little galena, which are ordinarily found in seams and veins, but in some places are distributed throughout the barite.

An analysis of this barite, made by Ricketts and Banks, is given below:[7]

Analysis of Kings Creek barite

$BaSO_4$	93.59
Fe_2O_4	0.32
CaO	0.02
MgO	trace
SiO_2	4.76

Several prospects on similar barite deposits have been located near the North Carolina line about midway between Kings Creek and Kings Mountain. The veins that were opened were lenticular, not very large, and owing to the long haul to a railroad do not appear to be of commercial value at present.

North Carolina

The barite deposits of North Carolina are associated with pre-Cambrian granites and schists. On the Kings Mountain Ridge, which runs in a south-southwesterly direction from Bessemer City for several miles, there are a number of openings on lenticular veins of barite, which are closely associated with sericitic schists. The principal mines are located 5 miles south of Bessemer City, at the north end of the ridge. Most of the barite-bearing veins are east of the highest part of the ridge and lie parallel to the schistosity of the inclosing rocks. The barite is granular and is associated with quartz, galena,

7 - Sloan, Earl, Catalogue of the Mineral Localities of South Carolina. South Carolina Geol. Survey, 4th ser., Bull. 2, 1908, pp. 125 - 126.

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and sphalerite. Most of the production of barite in the past has come from the vicinity of Stackhouse, Madison County. The Madison County barite belt is about 5 miles long, and extends from Bluff, on Spring Creek, in a northeast direction through Doe Run, and crosses French Broad River near Sandy. In this belt, which is close to a large thrust fault, are infolded remnants of Cambrian quartzite in the Archean granite, which is the general country rock. The barite occurs in narrow, irregular veins in the granite, particularly near the contact with the quartzite, and to a less extent in the quartzite. There is said to be very little impurity in the Stackhouse barite.

Connecticut

In Connecticut barite occurs in veins closely associated with trap dikes in the Triassic sandstones of the Connecticut River Valley. The principal locality in which mining has been carried on in the past is in Cheshire, 10 to 12 miles north of New Haven. In this locality lens-like veins from 2 to 4 feet wide, consisting of nearly pure barite with a little galena and chalcopyrite, are found both parallel to and cutting the bedding of the sandstone.

It is said that farther north, extending into Massachusetts, small discontinuous veinlike bodies of barite are found in the pre-Cambrian schists and gneisses.

Kentucky

The barite deposits of Kentucky are found in the central or Blue Grass region, and in the counties of western Kentucky lying immediately east of the Tennessee River.

In 19 counties centered about Lexington there are veins of barite lying along or near zones of faulting having a predominant northward trend. These faults are approximately parallel to the major axis of the Cincinnati arch, and are closely related in age to the folding. Normal faulting of several hundred feet displacement, and horizontal or slip faulting of a few feet have taken place parallel to the strike of the vein. The faults are marked by brecciated zones. The barite veins are found in the brecciated fault zones, and are larger and more productive in the limestone members than in the shale members. They are nearly vertical, irregular in width, average 2 to 4 feet in width, and attain a maximum width of 16 feet. Calcite, fluorite, galena, sphalerite, and pyrite occur in greater or less abundance throughout these veins, but masses of pure barite are common. Most of the barite is finely crystalline, occurring as granular masses rather than as aggregates of large well-developed crystals.

The following analyses[8] are said to represent samples of typical Kentucky barite.

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8 - Kentucky Geol. Survey, 4th Ser., vol. 1, pt. 1, pp. 449-451.

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Analyses of Barite from Kentucky

	1	2	3	4	5	6	7	8	9	10	11
Ignition (moisture, carbon dioxide, hydrocarbons . . .	0.17	0.34	0.87	0.28	0.62	0.23	1.40	0.65	0.15	1.19	0.28
Silica	.34	.11	.11	.25	.10	.05	.55	.18	.10	.20	.23
Iron oxide	.06	.62	.04	.06	.06	.03	.06	Trace	.04	.08	Trace
Barium oxide	50.86	50.96	60.26	64.72	59.80	50.96	54.95	10.71	64.68	49.98	60.55
Strontium oxide	8.99	11.65	3.80	Trace	2.41	11.10	6.75	45.06	.20	11.07	3.72
Calcium oxide	3.61	Trace	.76	Trace	2.09	.88	.20	.25	Trace	Trace	Trace
Sulphur trioxide . .	33.87	36.31	34.60	33.82	33.23	35.66	34.22	42.28	33.97	35.12	35.38
Fluorine	2.45	Trace	.52	.00	1.42	.60	.14	.00	.00	.50	.00
Zinc oxide	Trace	.00	.00	.00	.00	.00	1.23	.00	.00	1.50	.00
	100.35	99.39	100.96	99.13	99.73	99.51	99.50	99.13	99.14	99.68	100.16

1. John Baughman, prospect, one-half mile north of Danville, Boyle County, white and gray banded barite with calcite.
2. Lee River prospect, one-half mile south of Harrodsburg, Mercer County, cream-colored arborescent barite.
3. Farris prospect, 4 miles northeast of Danville, Boyle County, fibrous white barite.
4. Meyers prospect, near Mexico, Crittenden County, pure white barite; some iron stain.
5, 6. Ray mine, 2 miles from Fredonia, Caldwell County. 5, soft white fibrous barite; 6, hard fine granular barite.
7. Hayden open-cut, 1½ miles south of Danville, Boyle County, impure altered barite.
8. Truesdale, Owen County, celestite.
9. Perkins prospect, 1½ miles southeast of Burgin, Mercer County, dark-gray barite.
10. Mosly prospect, 1½ miles south of Shyrock Ferry, Woodford County, arborescent creamy barite; contains some copper.
11. Shelton open cut, 4 miles east of Danville, Boyle County, white lamellar barite.

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In western Kentucky workable bodies of barite are found in some of the veins that are mined for fluorspar. The veins occur in limestones, sandstones, and shales, which have been fractured, faulted, and intruded by basic igneous dikes. Fluorite, barite, calcite, galena, and sphalerite are the most widely distributed minerals. They occur both in veins and as replacements of the wall rocks, particularly in brecciated zones or beds. Ordinarily the minerals are more or less intergrown; banding is common, however, but deposits of any one mineral are rarely found.

MINING METHODS

The mining of barite in the United States is carried on by three distinct methods: (1) Surface mining by hand, which predominates in Missouri; (2) mechanical mining on the surface, as in Georgia and Tennessee, and; (3) underground mining, as in California.

Practically half of the barite mined in the United States is produced by hand-mining methods. In Missouri, where this method is used very extensively, the miner's tools comprise a pick and shovel, a small hatchet, a hand windlass, a rope and bucket, and a rattle box, or cradle screen. The miner selects a location, upon which he sinks a pit or shallow shaft from 3 to 5 feet in diameter. The pit may be circular, but if the shaft is cribbed the upper part is usually square. The pit is very seldom sunk too deep to permit the miner to throw out the dirt by hand. If he can not throw out the dirt he must have someone to work the windlass. On the surface the dirt is worked over by pick and shovel, the lumps of barite are sorted out, and the larger pieces are cleaned of the adhering clay with a hatchet. Should the ore body be of sufficient size and show a tendency to branch out, drifting is carried on until the ore runs out or the roof caves in. When this occurs, or bedrock is reached, another pit is started, often within 8 or 10 feet of the first and in the direction of the best ore. Drifts from one pit often lead into those from an adjacent one. The pits may be anywhere from 4 to 30 feet deep, but generally average 8 to 12 feet.

As a rule, all the material associated with the barite is thrown out of the pits, although some miners do not remove more than is absolutely necessary. The miner always tries to remove the barite in the area between the pits, and thus he finally succeeds in getting all there is on his lot, which is usually 60 feet square. Occasionally the undercutting or drifting is carried as much as 8 to 10 feet from the pit, especially when the pit is of windlass depth. In such cases drifting is easier than sinking another shaft.

Hand methods, in many cases, have proved highly inefficient; some deposits have been worked over two, three, and sometimes four times, illustrating the poor recovery of the total barite in the ground by this method. Steam shovels have been able to work over ground that has been hand-mined several times and still produce sufficient quantities of barite. In the Missouri region, however, hand-mining methods are the most profitable and best adapted to deposits where the barite occurs in large lumps, or where the irregular bedrock makes mechanical methods difficult.

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Mining is usually carried on by operators who have leased the mineral rights, or by owners. The operators or owners construct a number of small houses which usually are furnished rent-free to the miners, who work always on piece work or contract for a price per ton of barite cleaned and piled up by the side of the pit ready to load into trucks or wagons. The miner is in honor bound to sell his ore to the operator who owns or leases the land. The hauling of the ore from the pit to the railroad track or spur is also usually done on a contract basis. At the railroad track the operators have built storage facilities, both open and covered, where the ore is sampled and weighted, and checks are drawn to the order of both the miner and the hauler for the grade and amount of barite handled. The hauler is as independent as the miner, and each must be recognized by name in the transaction.

The hauling price varies, partly with the richness of the ground but mostly with the distance from the railroad. The price ranges from 50 cents to $4 per ton. The market price for barite affects the contract price for digging, and in some instances for hauling.

In the central district of Missouri hand methods differ somewhat from those generally used, because the deposits are usually on a steeper slope and of less horizontal extent. The deposits are opened by starting a cut in the hillside and widening the cut as it is deepened. A nearly vertical face is developed and broken down by picks, or sometimes by barring from above. The barite and clay are separated on the pit floor and hauled out separately. Large boulders are left in place and mined around.

POWER SHOVEL MINING

In Georgia and Tennessee the mining of barite is practically always done by steam shovel, and even in Missouri several deposits are being worked by this method at present. The best conditions for power shovels are in gently sloping ground where the deposits cover large areas. The shovels are especially suitable where the barite occurs in small pieces, uniformly distributed through the clay rather than in large lumps or sheets.

The machines generally are mounted on broad-tired trucks and are moved about on heavy planks laid on the floor of the cut. They are usually equipped with 1/2 or 3/4 yard dippers. Dump cars of 2 to 3 yards capacity pulled by dinkey locomotives convey the ore to the washer. Usually the cut is opened at such a level that the mine cars have a slight down grade to the tipple or dump at the head of the washer. In a few places where this is not feasible the loaded cars are pulled up an incline to the washer head.

Blasting is resorted to when necessary to loosen up the ground ahead of the shovels. Large boulders of limestone and sometimes of quartzite, are left in the cut when encountered. High working faces are dangerous, as slides often develop which may entirely cover the shovels.

With the present cost of operation in the Georgia and Tennessee fields, an ore yielding 5 per cent $BaSO_4$ is the lowest grade workable. The average deposits mined probably range between 12 and 20 per cent, and in some places 40 per cent ore has been mined. The deposits being worked are from 10 to 80 feet thick. No stripping is required, as the ore usually begins at the surface.

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While the size of the deposits vary, the open-cuts are usually between 150 to 250 feet in diameter. The pockets or enriched areas comprising the open-cut may yield from 15,000 to 60,000 tons of washed barite, the latter being unusual. The deposits are usually close enough so that three or four may be worked out before it is necessary to move the washing plant.

The distance between the deposit and the washer is ordinarily not very great, seldom exceeding one-quarter mile.

UNDERGROUND MINING

California is the principal state in which barite is mined underground; the deposits at El Portal, Mariposa County and at Alta, near Dutch Flats, Placer County, are worked in this manner.

At El Portal the deposit is located on the side and top of a steep hill overlooking the Merced River. A quarry near the top was first opened, and as this was worked farther into the hillside short tunnels were driven back along the most likely veins. The deposit is worked with air drills, and the rock is shot down. It is brought out to the quarry floor in man-size pieces and hand-picked. The witherite is separated from the barite, and when a sufficient quantity of either is on hand it is loaded into a small car for delivery to the storage bins. These bins are located on the side of the hill just above the railroad track, so that the freight cars can be loaded by gravity. The cars on the quarry floor are loaded by hand and pushed to the edge of the hill. There it is attached to a cable and lowered down the incline track to the storage bins. While it is being lowered the empty car is brought up the hill to the quarry floor.

At Alta the barite is mined underground and brought to the surface throu an adit tunnel driven into the side of the hill. There it is loaded upon an aerial tramway car holding about 1 ton, and is carried across a canyon and dumped into loading bins. From there it is dropped by gravity into trucks and hauled about 3 miles to the rail spur and again dumped into bins, from which it can be loaded directly into freight cars.

WASHING AND MILLING

The preparation of crude barite for market varies in different plants, in different localities, and according to the condition of the crude ore.

In the southern field the crude barite is handled mechanically, though some hand treatment is used. The general practice in Georgia and Tennessee, however, is very simple and, as indicated in the flow sheet, Figure 1, involves the following steps:

The rock is dumped from the quarry cars upon a grizzly, the rails spaced about 6 inches apart. At some plants the ore is dumped into a revolving screen, the oversize from which falls to the grizzly and is sledged through into a trough below. From the trough the ore and clay is carried by a heavy flow of water into a double log washer.

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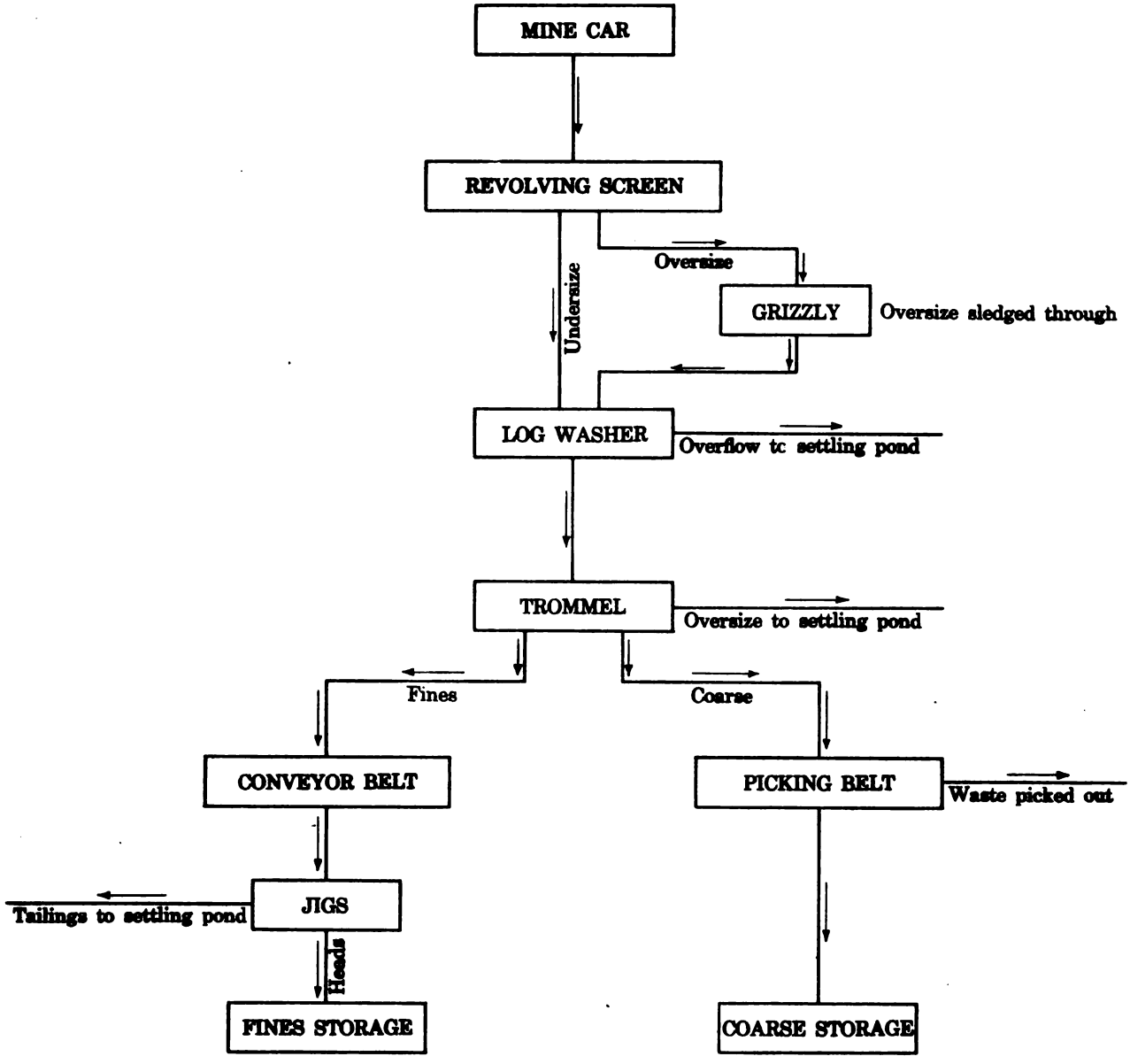

Figure 1.– Flow sheet of typical barite washing plant

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The log washers are generally about 30 feet long. The overflow is wasted to a settling pond, and the heads or washed barite and rock discharge to a trommel. The logs, which are generally made at the plant, are of yellow pine timbers 18 inches in diameter. They are fitted with the usual cast-iron sockets at the ends, and with flights of chilled iron applied with lag screws. The logs have a slope of 1 inch per foot, and rotate at a speed of about 20 revolutions per minute. At the head ends the logs are geared together, and one is driven by a pinion from a countershaft. One log has right-hand and the other left-hand flights, and they are driven so that they lift the material at the center.

The trommel receiving the log discharge is about 4 by 8 feet and may be conical or cylindrical. Punched plate with 1-inch openings is the usual screen. At one plant a screen making two through sizes 1 inch and five-eighths inch, was in operation. The oversize from the trommel discharges to a 24-inch picking belt from which the waste is taken off, the belt discharging to the storage bin for cleaned lump barite. Ordinarily about 50 per cent of the material delivered to the belt is picked off as waste. Some of the deposits contain a stiff compact clay which is not disintegrated by the logs. This comes through the trommel as rounded balls, often containing fragments of barite, and increasing the work on the picking belt. The fines from the screen go to a bucket elevator. The discharge head of this is so arranged with a splitter parallel to the plane of the belt that two products are roughly classified by centrifugal force. The two sizes go to 3-cell jigs with a 1/8-inch screen. The jig concentrates go to the shipping bins, and the tailings to the settling pond. Most of the hutch product is stocked; it contains 50 to 70 per cent $BaSO_4$ and, wherever possible, some of it is graded in with shipments of lump or high-grade concentrates when the specifications will permit. Some of it is ground at the plants and shipped as a filler for certain uses. Plants in general have a capacity of 5 to 15 tons of washed barite (equivalent to 35 to 40 tons of ore) per hour, depending on the richness of the material. Most plants are served by railway sidings so that the washed barite is loaded directly into freight cars for the market. As shipped, the cleaned ore will contain 90 to 96 per cent $BaSO_4$.

In the Missouri field the washing and million of barite follows closely the methods used in Georgia and Tennessee, though the industry in Missouri has been somewhat slow in adopting mechanical methods because of the low cost of labor, the ease with which the ore can be cleaned by hand, and the uncertainty of having deposits of sufficient size to justify the capital outlay.

Standard practice comprises log-washing to remove the clay, followed by comparatively coarse crushing, jigging, and table treatment of the fines. In detail the practice varies from a simple flow sheet to a rather elaborate one, depending partly on the ideas of the operators as to what constitutes true efficiency, but more on the grade of concentrates necessary to supply the different markets. It must be remembered that barite is a cheap commodity valued at only $6 to $8.50 per ton f.o.b. cars, and that consequently refinements of concentrating methods necessary to secure a higher percentage recovery can not be employed unless the extra cost is extremely low. It should be remembered, however, that a very large amount of waste material, the clay, is eliminated by the log washer in the first operation, and even if the original feed to the logs contains only 7 to 8 per cent barite the product leaving the logs and going to the jigs may contain from 25 to 45 per cent.

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In California and Nevada practically none of the ore needs treatment at the mine. The rock is loaded directly on to freight cars as it comes from the mine storage bins, and is hauled to the crushing and grinding plant.

As compared with modern concentrating plants of substantial construction, which are well housed and designed for many years' operation, the plants for washing barite generally appear poorly designed and of only a temporary nature. However, when due consideration is given to the fact that three or four years, at the most, is the usual life of a deposit and that the plant must then be scrapped or moved, the reasons for the temporary type of construction are apparent. Many of the plants are not roofed except for a shed over the picking belt, jigs, and motors.

WORLD'S PRODUCTION

The growth of the barite industry of the world has paralleled that of the United States, and such countries as Germany, Italy, Great Britain, and Australia have shown favorable gains in recent years.

In 1908 the world produced 178,129 short tons (Table 1). With the exception of 1910, the production grew steadily, though at the beginning of the World War there was a slight decrease. By 1925 the production of barite for the world amounted to 591,000 short tons, the all-time record for barite production.

The United States is now the leading source of supply and in the last few years has produced nearly one-half of the world's output. Since the world-wide depression year, 1921, the world's production for the six-year period, 1922 to 1927, inclusive, has averaged 535,457 short tons annually of which the United States has made an average annual production of 214,259 short tons, or 40 per cent. For this same period Germany, as shown by the production figures for Bavaria, Prussia, and Saxony, averaged 171,924 short tons, or 32 per cent of the total. (Table 1.) These two countries, therefore, furnished on an average during this period 386,183 tons, or 72 per cent of the world's production.

Great Britain and Italy are the only other large producers of barium minerals, the former producing witherite and barite, and the latter barite only. Great Britain's average for this six-year period was 51,804 short tons, or 10 per cent of the total, and Italy's average was 33,653 tons, or 6 per cent.

The World War, though it substantially altered the relative importance of Germany and the United States as sources of supply, had only a slight effect upon the total output of barite, as the world's average for the five-year period 1914-1918 was 261,597 short tons. The United States for this period averaged 149,100 tons, or 57 per cent of the world's total. Germany's share of the barite industry during the five years, however, averaged only 11,742 tons, or 4 per cent. Great Britain and Italy produced an average of 71,536 tons, or 27 per cent, and 19,051 tons, or 7 per cent, respectively.

In recent years Australia has been showing a slight increase in output, producing 2,336 short tons in 1927 and 2,650 tons in 1928, while France, as far as figures are available, has also been making rapid strides, producing in 1926, 42,780 tons. The peak of production in that country was 48,710 tons in 1924.

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Table 11. World production of barium minerals, 1908-1928 (in short tons)

Year	Australia 1/	Austria 2/	Belgium 3/	Canada 4/	France 5/	Germany		Total Germany	Great Britain 8/	India 9/	Italy 10/	Spain 11/	United States 12/	Other Countries 13/	Total 14/
						Bavaria 6/	Other 7/								
1908	-	-	27,635	4,312	17,942	18,954	9,429	28,383	45,621	-	17,341	368	38,527	-	178,129
1909	-	-	34,612	179	15,555	19,753	16,740	36,493	46,778	-	17,901	465	61,945	-	213,928
1910	-	-	5,401	-	12,822	27,239	15,247	42,486	50,027	-	15,895	525	42,975	-	170,131
1911	-	-	27,778	50	11,094	28,918	16,550	45,468	49,412	-	15,013	700	38,445	-	187,960
1912	-	-	55,715	464	15,013	29,981	17,495	47,476	50,822	-	14,793	1,208	37,478	-	202,969
1913	606	-	13,228	641	13,488	15/ 30,122	56,292	86,414	56,060	-	14,297	3,361	45,298	-	233,385
1914	815	-	-	612	-	19,862	-	19,862	54,802	-	14,297	2,727	52,747	-	145,862
1915	412	-	-	550	-	7,874	-	7,874	69,974	-	19,676	4,650	108,547	-	211,683
1916	1,371	-	-	1,368	-	13,761	-	13,761	85,158	-	23,865	11,583	221,952	-	359,058
1917	1,406	-	-	3,490	-	11,242	-	11,242	73,424	-	20,944	11,185	206,888	-	328,579
1918	2,281	-	-	640	-	6,071	-	6,071	74,323	3,051	16,474	4,597	155,368	-	262,805
1919	3,117	-	-	468	13,074	9,722	59,947	69,669	67,297	2,901	21,374	12,651	209,330	-	399,861
1920	4,270	-	16,799	751	20,705	8,695	114,613	123,308	71,848	759	16,953	15,182	228,113	362	499,048
1921	1,647	2,293	18,794	270	12,453	25,857	94,050	119,887	27,629	1,894	14,881	1,003	66,369	-	267,120
1922	2,124	2,359	1,631	289	13,926	17,790	181,180	198,870	45,863	2,679	23,479	8,493	155,040	1,376	456,229
1923	2,084	2,620	7,465	409	28,727	22,013	107,151	129,164	48,717	2,878	30,415	20,320	214,183	900	487,880
1924	2,293	1,542	22,586	151	48,710	16/ 27,673	112,794	140,467	61,339	2,579	43,616	15,928	196,332	1,434	556,977
1925	2,472	1,502	14,539	95	45,690	24,741	166,715	191,456	54,523	1,624	35,489	9,683	228,063	5,864	591,000
1926	2,175	1,065	6,724	100	42,780	29,712	149,162	178,874	47,908	2,588	35,103	8,755	237,875	16,773	580,718
1927	2,336	2,121	1,797	56	-	22,085	170,629	192,714	52,475	1,926	33,815	8,506	254,265	9,930	559,940
1928	2,650	-	-	127	-	-	-	-	-	-	-	-	269,544	85	272,406

1/ 1913-1919, The Mineral Industry of the British Empire and Foreign Countries, Barium Minerals (1913-1919), Imperial Mineral Resources Bureau, London; 1920-1927, Barite and Barium Products, Mineral Resources of the United States (Annual), U. S. Bureau of Mines.
2/ Barite and Barium Products, Mineral Resources of the United States (Annual), U. S. Bureau of Mines.
3/ 1908-1913, Mineral Industry during 1913, New York, 1914, p.42; Barite and Barium Products, Mineral Resources of the United States (Annual), U. S. Bureau of Mines.
4/ Mineral Production of Canada (Annual), Ottawa.
5/ 1908-1913, Mineral Industry during 1913, New York, 1914, p.42; 1919-1927, Barite and Barium Products, Mineral Resources of the United States (Annual) Bureau of Mines.
6/ 1908-1913, Mineral Industry during 1913, New York, 1914, p. 947.
7/ Baden, 1908-1913, Mineral Industry during 1913, New York, 1914, p. 947; 1913 includes 38,169 tons for Prussia, Mineral Resources of the United States, 1923, p.81; Prussia, 1919-1927, Barite and Barium Products, Mineral Resources of the United States (Annual), U. S. Bureau of Mines.
8/ Mines and Quarries, Part 3, General Report, Chief Inspector of Mines, Home Office (Annual), London.
9/ 1918-1919, Mineral Industry during 1927, New York, 1928, p. 60; 1920-1927, Barite and Barium Products, Mineral Resources of the United States (Annual) U. S. Bureau of Mines.
10/ 1908-1909, Mineral Industry during 1910, New York, 1911, p. 69; 1910-1927, Revista del Servisio Minerario (Annual), Rome.
11/ 1908-1919, Mineral Industry during (Annual), New York.
12/ 1908-1927, Mineral Industry during (Annual), New York.
13/ Algeria, Japan, Rhodesia, and Russia; Barite and Barium Products, Mineral Resources of the United States (Annual), U. S. Bureau of Mines.
14/ Includes only those countries for which figures are available.
15/ Includes 148 tons for Saxony, Barite and Barium Products, Mineral Resources of the United States, 1923, p. 81.
16/ Includes 2,288 tons for Saxony.

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The statistics of the industry and the fact that new uses are being brought forward constantly both indicate that the world production of crude barite should advance rapidly.

DOMESTIC PRODUCTION

While there has been a steady growth in the barite industry extending back as far as 1882, the great increase in the domestic production of crude barite, beginning in the year 1915, was due partly to the cutting off of foreign supplies of barite and barium chemicals. War conditions forced eastern manufacturers in the United States to seek a domestic supply of their raw material, and resulted in the establishment of a barium chemical industry in this country. Moreover, there was also a perceptible natural development due to the increased demand for barite in the manufacture of lithopone, and to a greater use of ground barite and blanc fixe, particularly in the rubber and paper industries.

The domestic output of crude barite increased about fourfold from 1914 to 1916, or from 52,747 short tons to 221,952 tons. With the entrance of this country into the war, the domestic production showed a decided falling off; the 1918 figure decreased 25 per cent. from that for the preceding year. After the armistice the American mines attained in 1920 a maximum output of 228,113 short tons, but this record figure was followed by a sudden drop to only 66,369 tons in 1921. The production in 1922 advanced to 155,040 tons (Table 2). The decided falling off in 1921 was the result of the world-wide depression affecting all commodities, both at home and abroad, which followed the post-war inflation period.

The upward trend in the production of barite since 1924 has been steady, and in 1928 the output amounted to 269,544 short tons, valued at $1,754,924, or $6.51 per ton. This represents the largest output of crude barite in the history of the industry in the United States.

During the past 15 years production in the United States has increased 550 per cent; in Missouri the increase amounted to 380 per cent. This rate of increase is probably more than that for any other similar mineral commodity, and speaks well for the future of the industry. The increased use of barite as a filler in the rubber industry and the phenominal growth of the lithopone and blanc fixe industries in recent years has accounted for the rapid increase in the production of this mineral.

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Table 2. - Production of crude barite from 1882-1928

Year	Quantity, short tons	Value	Average price per ton
1882	22,400	$80,000	$3.57
1883	30,240	108,000	3.57
1884	28,000	100,000	3.57
1885	16,800	75,000	4.46
1886	11,200	50,000	4.46
1887	16,800	110,000	1/ 6.55
1888	22,400	75,000	3.35
1889	21,460	106,313	2/ 4.95
1890	21,911	86,505	3.95
1891	31,069	118,363	3.81
1892	32,108	130,025	4.05
1893	28,970	88,506	3.06
1894	23,335	86,983	3.73
1895	21,529	68,321	3.17
1896	17,068	46,513	2.73
1897	26,042	58,295	2.23
1898	31,306	108,339	3.50
1899	41,894	139,528	3.33
1900	67,680	188,089	2.78
1901	49,070	157,844	3.22
1902	61,668	203,154	3.29
1903	50,397	152,150	3.02
1904	65,727	174,958	2.66
1905	48,235	148,803	3.08
1906	50,231	160,367	3.19
1907	89,621	291,777	3.26
1908	38,527	120,442	3.13
1909	61,945	209,737	3.39
1910	42,975	121,746	2.83
1911	38,445	122,792	3.19
1912	37,478	153,313	4.09
1913	45,298	156,275	3.45
1914	52,747	155,647	2.95
1915	108,547	381,032	3.51
1916	221,952	1,011,232	4.56
1917	206,888	1,171,184	5.66
1918	155,368	1,044,905	6.73
1919	209,330	1,727,822	8.25
1920	228,113	2,142,464	9.39
1921	66,369	531,958	8.02
1922	155,040	1,123,950	7.25
1923	214,183	1,664,156	7.77
1924	196,332	1,540,744	7.85
1925	228,063	1,703,097	7.47
1926	237,875	1,773,293	7.45
1927	254,265	1,670,878	6.57
1928	269,544	1,754,924	6.51

1/ Value at St. Louis; includes some floated barite..
2/ Value includes floated barite when sold first in that form.

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PRODUCTION BY STATES

The principal States producing barite in the United States, according to their importance, are Missouri, Georgia, Tennessee, California, and South Carolina, though several other States have a small intermittent output of this mineral. Georgia was the leading producer during the years 1916 to 1919, inclusive.

Missouri

Except during the war years, the barite deposits of Missouri have usually furnished by far the larger part of the domestic production. Prior to the war, about 65 per cent of the domestic output of crude barite was from Missouri, which supplied the mid-western market for ground barite. In 1914 the barite produced in Missouri amounted to 63 per cent of the total for the United States, but the following year, despite an increase in output of 5,000 tons, it contributed only 36 per cent of the total production. In 1916 the production was nearly twice as large as it was in 1914 but amounted to only 26 per cent of the total. From then on Missouri increased its percentage of the total until in 1926 it was furnishing half of the total production of the United States.

In recent years the barite industry in Missouri has been quite stable and more or less prosperous. Production has increased steadily, and the introduction of more modern methods, both at the deposits and at the plants, has resulted in increased recoveries and reduced costs. Some of the larger producers are conducting systematic research to extend the uses of barite and are planning their operations so as to provide for future developments.

In 1915, the year that Georgia became a factor in the production of crude barite in the United States, Missouri produced 39,113 short tons of barite valued at $158,597. The following year the production advanced to 58,223 short tons valued at $365,111, an increase of 49 per cent in quantity and 130 per cent in value. For the next eight years, or until 1924, the production fluctuated between 25,200 tons and 99,654 tons, the low point coming in 1921, with a value of $217,913, and the high point in 1920, with a value of $1,013,570. In 1925 the production in Missouri reached 100,000 tons for the first time in the history of the industry in that State (101,056 short tons). The value for the barite this year was $794,927. The production advanced in 1926 to 118,919 tons having a value of $946,595, while in 1927 there was a slight decrease in both quantity and value (111,456 short tons, valued at $797,465). In 1928, Missouri produced 114,274 short tons or slightly less than in 1926, the peak year in the barite industry in that State. This production was valued at $810,203, or $7.09 per ton.

Georgia

Prior to 1915 the production of barite in Georgia was of little consequence, and the figures were included under "Other States." As a result of the increased activities of the mines in Georgia, Tennessee, and Kentucky, the total production for the United States during 1915 represents an increase of over 100 per cent in quantity and of well over 100 per cent in value, as compared with 1914.

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While the production figures for Georgia from 1915 on represent the total output for the State, practically the whole production comes from the Cartersville district.

The closing of the German sources of crude barite and barium chemicals to the United States forced the consumers of these commodities along the Atlantic seaboard to look to their own country for their requirements. Practically the entire production of crude barite in Missouri was being consumed by the industry in the mid-western States, and the mines there were unable to supply immediately the requirements of the eastern manufacturers. Freight rates from the Missouri field to the eastern markets were also a factor in bringing Georgia to the front as the leading producer of barite in 1916 and for several years thereafter.

In 1915 Georgia produced 31,027 short tons of crude barite valued at $102,825, while in 1916 the production for the State advanced to 104,784 tons valued at $401,295, an increase of 237 per cent in quantity and 290 per cent in value. In 1917 the production advanced to 111,300 short tons valued at $601,895, a slight increase in quantity but an increase of 50 per cent in value. While the production in Georgia for the next two years was much larger than in Missouri, it showed a decrease from the previous two years; nevertheless, it still remained well over twice the amount produced in 1915. From 1920 on, following the reappearance of German barite on the American market, Georgia took second place as a producer of crude barite. While the output in Georgia has again shown a steady increase during the past three or four years, this increase has not kept up with that of Missouri, due to the resumption of imports of considerable quantities of German ore. The production in 1928, however, because of the increased demand for barite along the Atlantic seaboard, increased to 112,316 tons valued at $675,509, the largest output in the history of the industry in Georgia.

Tennessee

The deposits of barite in the vicinity of Sweetwater, Tenn., have been producing crude barite at least since 1873, in which year over 500 tons were shipped from Greene, Hamblen, and Monroe Counties.

In 1902 Tennessee produced 3,255 short tons valued at $14,647. During the early years of the industry - that is, from 1902 to 1914 - the output fluctuated between 2,098 tons in 1913 to 20,861 tons valued at $37,138 in 1907. During the latter year there was only one plant in the State producing ground barite, the larger part of the crude ore being shipped out of the State.

With the beginning of the World War production increased until in 1919 the output of the State was recorded as 34,700 short tons valued at $288,622; however, while this is a very favorable increase, it does not compare with that of Georgia or Missouri for the same period. In the post-war depression year of 1921 the production fell off considerably, to 8,180 short tons valued at $61,148. Since then the yearly output has fluctuated between 16,642 tons valued at $124,204 in 1922 and 47,012 tons valued at $345,038 in 1925. This year, incidentally, recorded the highest output in the history of the industry in Tennessee. The production in 1928 was 20,260 tons, valued at $150,937.

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California

According to the reports of the California State Department of Natural Resources, the first recorded production of barite in that State was in 1910. The following Table 4, shows the output of crude barite from 1910 to 1928:

Table 4. - Production of crude barite in California, 1910-1927[1]

Year	Quantity, short tons	Value	Year	Quantity, short tons	Value
1910	860	$5,640	1919	1,501	18,065
1911	309	2,207	1920	3,029	20,795
1912	564	2,812	1921	901	4,809
1913	1,600	3,680	1922	3,370	18,925
1914	2,000	3,000	1923	2,925	16,058
1915	410	820	1924	- - -	- - -
1916	1,606	5,516	1925	- - -	- - -
1917	4,420	25,633	1926	4,978	38,165
1918	100	1,500	1927	17,993	90,617
			1928	12,557[2]	51,502[2]

1/ Calif. Mineral Production in 1927, Division of Mines, Bull. 101, Sacramento, Sept., 1928.
2/ U. S. Bureau of Mines original production schedules.

The figures in Table 4 do not quite agree with those available for publication by the U. S. Bureau of Mines, but they are reasonably close.

It is only within very recent years that the crude barite industry in California has been showing an increase. The war period had little, if any, effect on the output of this mineral. The market for crude barite did not expand as in the East, and as barite is a relatively cheap commodity, the cutting off of German barite imports did not bring about shipments of this mineral to the eastern markets.

The depression year of 1921 was felt in the California industry, the production falling from 3,029 short tons valued at $20,795 in 1920, to 901 tons valued at $4,809. The production in 1927, the highest ever recorded in the industry, reached 17,993 tons valued at $90,617, an increase of 333 per cent in quantity and 137 per cent in value, as compared with 1926 (4,978 tons, valued at $38,165). The figures for 1928 as recorded by the U. S. Bureau of Mines were 12,557 tons valued at $51,502.

North Carolina

The mining of crude barite at one time assumed an important place in the mineral production of North Carolina, which in 1902 produced 14,679 short tons of crude barite valued at $44,130. After that year, however, with the exception of 1904, the industry slowly declined until in 1926 production ceased.

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IMPORTS

The imports for consumption of crude barite into the United States from 1890 to 1914 ranged from a minimum of 502 short tons in 1897 to 35,840 tons in 1913. With the advent of the war they exhibited a decided decrease, until in 1918 no foreign barite was imported. The average price of the few tons that were imported in 1916 and 1917 was extremely high, amounting to $14.41 per ton in 1916 and $10.50 in 1917.

The annual imports for consumption for the 10-year period prior to the war (1905-1914) averaged 19,723 short tons, valued at $50,055, or an average of $2.76 per ton. The imports in 1919 amounted to only 118 tons valued at $594. The nine-year period from 1920 to 1928, inclusive, averaged 34,153 tons annually, valued at $137,661, or $4.50 per ton.

Prior to the war the Atlantic coast market was supplied exclusively by imports, chiefly from Germany, amounting to between 35 and 45 per cent of the total domestic consumption of crude barite. At interior points the price was determined by the price of barite at Atlantic ports plus the cost of transportation. The outlet for domestic crude barite prior to the war was restricted to supplying the middle western manufacturers of ground barite, whereas the imported crude barite was consumed almost wholly by eastern manufacturers of lithopone.

The imports of crude barite, though they have grown since the war, now constitute a smaller percentage of the domestic supply than they did before 1914. The deposits of barite in the southern district have an advantage over Missouri deposits of approximately $1.25 per ton in freight rates to the Atlantic Coast market. War conditions did not change the competitive situation as far as Missouri producers of crude barite are concerned. With normal conditions restored, competition in crude barite in the Atlantic market again made possible the importation of the German product, and the southern district was forced to reduce its costs, its output or to obtain a market elsewhere. It was claimed that in

> August, 1929, German crude barite could be laid down on the Atlantic seaboard at about $11 per short ton, including a tariff of $4 per ton, as compared with a cost price of about $7 per ton f.o.b. cars, Cartersville, Ga., district, plus freight to consumers in the East, which brings the total cost to the neighborhood of $13 a ton for domestic crude barite. Missouri ore costs $14 to $14.50 per ton on the Eastern market.

Table 5 shows the imports of crude barite for consumption into the United States for the years 1890 to 1928, inclusive:

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Table 5.- Crude barite imported for consumption, 1890-1928
(Short tons)

Year	Quantity	Value	Average price per ton
1890	4,815	$ 13,133	$2.73
1891	2,900	8,816	3.04
1892	2,789	7,418	2.66
1893	2,983	7,612	2.55
1894	1,844	5,270	2.86
1895	2,551	7,561	2.96
1896	509	1,274	2.50
1897	502	579	1.15
1898	1,022	2,678	2.62
1899	1,739	5,488	3.16
1900	2,568	8,301	3.23
1901	3,150	12,380	3.93
1902	3,929	14,322	3.65
1903	7,105	22,777	3.21
1904	7,492	27,363	3.65
1905	14,256	62,459	4.38
1906	9,190	27,584	3.00
1907	20,544	76,883	3,74
1908	13,661	58,822	4,31
1909	11,647	29,028	2.49
1910	21,270	48,457	2.28
1911	20,214	36,643	1.81
1912	26,186	52,467	2.00
1913	35,840	61,409	1.71
1914	24,423	46,782	1.92
1915	2,504	4,877	1.95
1916	17	245	14.41
1917	6	63	10.50
1918	0	0	-
1919	118	594	5.03
1920	24,874	146,858	5.90
1921	11,054	59,371	5.37
1922	23,239	104,680	4.50
1923	15,045	93,721	6.23
1924	21,502	104,264	4.85
1925	28,655	91,016	3.18
1926	51,016	195,004	3.82
1927	70,274	253,284	3.60
1928	61,765	190,756	3.09

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CONSUMPTION

With the exception of Missouri and California, very little crude barite is consumed in the States in which it is produced. Crude barite produced in Georgia and Tennessee is consumed in grinding and paint plants situated along the Atlantic seaboard, in Pennsylvania, and as far west as Illinois and Indiana. The larger part of the production of barite from Missouri is shipped to St. Louis, though plants at Argo, Collinsville, Chicago, Alton, Depue, and Blue Island, Ill., consume considerable quantities. Part of the production in South Carolina is consumed there and part is shipped northward to West Virginia and other neighboring States. With the exception of a few thousand tons shipped eastward, California consumes practically all of its production in plants located at Modesto, Daggett, and Oakland.

Consumers along the Atlantic seaboard rely to a considerable degree upon imported barite, especially from Germany. Prior to 1914 from 35 to 45 per cent of the domestic consumption of crude barite was imported. The imported product supplied the Atlantic coast market, as it could be obtained at less cost than domestic crude barite. It has been estimated that about 50 per cent of the ground barite manufactured in the Central States was, prior to the war, and still is shipped to and consumed in the Atlantic coast market. Foreign competition before the war was chiefly in crude barite. In 1913 the United States furnished 56 per cent of its requirements, producing 45,298 short tons of a total of 81,138 tons consumed; the imports accounted for 35,840 tons. In 1914 this percentage increased to 68 per cent, or 52,747 tons of a total consumption of 77,170; and the imports decreased to 24,423 tons.

During the past seven years (1922 to 1928, inclusive) the United States furnished an average of 222,186 short tons annually, or 85 per cent, of an average annual consumption of 260,971 tons, and imported annually an average of 38,785 tons.

Table 6 shows the apparent consumption of crude barite in the United States for the years 1910 to 1928, inclusive, while Figure 3 shows the production, imports, and apparent consumption, disregarding stocks on hand at the beginning and end of the year, for the years 1890 to 1928, inclusive:-

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Table 6.- Apparent consumption of crude barite in the United States 1910-1928
(Short tons)

Year	Stocks at beginning of year	Production	Imports	Exports	Stocks at end of year	Apparent consumption
1910	3,376	42,975	21,270	(2)	5,888	61,733
1911	5,888	38,445	20,214	(2)	6,162	58,385
1912	6,162	37,478	26,186	(2)	7,606	62,220
1913	7,606	45,298	35,840	(2)	9,181	79,563
1914	9,181	52,747	24,423	(2)	11,743	74,608
1915	11,743	108,547	2,504	(2)	9,676	113,118
1916	9,676	221,952	17	(2)	10,900	220,745
1917	10,900	206,888	6	(2)	20,000	197,794
1918	20,000	155,368	0	(2)	18,500	156,868
1919	18,500	209,330	118	(2)	22,518	205,430
1920	22,518	228,113	24,874	(2)	9,447	266,058
1921	9,447	66,369	11,054	(2)	38,950	47,920
1922	38,950	155,040	23,239	(2)	17,000	200,229
1923	17,000	214,183	15,045	(2)	(1)	246,228
1924	(1)	196,332	21,502	(2)	(1)	217,834
1925	(1)	228,063	28,655	(2)	28,700	228,018
1926	28,700	237,875	51,016	(2)	28,000	289,591
1927	28,000	254,265	70,274	(2)	37,000	315,539
1928	37,000	269,544	61,765	(2)	38,000	330,309

(1) Data not available.
(2) Exports of barite not separately classified.

PRICES

Prior to the World War the price of crude barite did not exceed $4.95 per short ton, except in 1887 when the price was $6.55 (Table 2). With the advent of the war the price gradually rose from $2.95 per short ton in 1914 to $6.73 per ton in 1918. The average pre-war price for the five-year period (1909-1913) was $3.38 per ton, as compared with $4.68 per ton for the war period (1914-1918), an increase of $1.30, or 38 per cent. The World War did not have as great an effect upon the price of crude barite as it did upon many other commodities. Due to the fact that the mining and beneficiation of barite for market requires only a comparatively small outlay of capital and time, the supply proved quite flexible, and both Georgia and Tennessee were able almost at once to furnish the requirements of the plants along the Atlantic seaboard which were cut off from German sources, as well as to take care of their usual markets. During the two years following the war, however, the price of crude barite continued to advance, reaching $8.25 per ton in 1919 and $9.39 in 1920. The latter figure is the highest price reached in the history of the industry. Subsequently the price has fluctuated, but has tended slightly to decrease, reaching $6.57 per ton in 1927 ($6.51 per ton in 1928).

According to Table 7 quoted from Engineering and Mining Journal-Press, the price of Missouri crude ore containing at least 93 per cent $BaSO_4$ and not more than 1 per cent iron, f.o.b. mines, averaged $8.01 per short ton in 1926. In 1927 and 1928 the averages were $8 and $6.92 per ton, respectively, with an upturn, however, in 1929.

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Table 7.- Market price of barite, 1926-1929[1]

(Price per ton f.o.b. mines on Missouri crude ore, 93% $BaSO_4$, not to exceed 1% iron)

Month	Year			
	1926	1927	1928	1929
January	$7.50	$8.00	$7.50	$7.25
February	8.00-8.50	8.00	7.50	7.25
March	8.00-8.50	8.00	7.50	7.25
April	8.00-8.25	8.00	7.50	7.00-7.25
May	8.00	8.00	6.50-7.50	7.25
June	8.00	8.00	6.50	7.25
July	8.00	8.00	6.50	7.25
August	8.00	8.00	6.50-7.50	-
September	8.00	8.00	6.50	-
October	8.00	8.00	6.50	-
November	8.00	8.00	6.50	-
December	8.00	8.00	6.50	-
Average:	8.01	8.00	6.92	-
High	$8.50	$8.00	$7.50	-
Low	$7.50	$8.00	$6.50	-

1 - Engineering and Mining Journal Press.

TARIFF HISTORY

Barite, or barium sulphate, unmanufactured or manufactured, has been dutiable since the passage of the act of 1883, with the exception of the period covered by the act of 1894, when barite unmanufactured, including barite earth, was free of duty. Witherite (natural barium carbonate) has uniformly been exempt from duty since 1883.

The duties levied on barite, unmanufactured and manufactured, and the provisions for witherite beginning with the act of 1883, are as follows:

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Duties levied on barite, manufactured and unmanufactured, and provisions for witherite, acts of 1883 to 1922

Act of-	Paragraph	Tariff classification	Rates of duty specified and ad valorem
1883	40	Baryta, sulphate of, or barytes, unmanufactured	10 per cent ad valorem.
1883	41	Baryta, sulphate of, or barytes, manufactured	¼ cent per lb.
1883	603	Baryta, carbonate of, or witherite	Free
1890	49	Baryta, sulphate of, or barytes, including barytes earth:	
		Unmanufactured	$1.12 per ton.
		Manufactured	$6.72 per ton.
1890	500	Baryta, carbonate of, or witherite	Free
1894	37	Baryta, sulphate of, or barytes, manufactured	$3 per ton.
1894	395	Baryta, carbonate of, or witherite, and baryta, sulphate of, or barytes, unmanufactured, including barytes earth.	Free
1897	44	Baryta, sulphate of, or barytes, including barytes earth:	
		Unmanufactured	75 cents per ton.
		Manufactured	$5.25 per ton.
1897	489	Baryta, carbonate of, or witherite	Free.
1909	42	Baryta, sulphate of, or barytes, including barytes earth:	
		Unmanufactured	$1.50 per ton.
		Manufactured	$5.25 per ton.
1909	711	Witherite	Free.
1913	51	Baryta, sulphate of, or barytes, including barytes earth:	
		Unmanufactured	15 per cent ad valorem.
		Manufactured	20 per cent ad valorem.
1913	646	Witherite	Free.
1922	69	Barytes ore, crude or unmanufactured	$4.00 per ton.
		Ground or otherwise manufactured	$7.50 per ton.
1922	1698	Witherite	Free.

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SUMMARY OF CONDITIONS IN THE DOMESTIC INDUSTRY

In the United States barite is produced in three distinct localities: (1) The Middle Western district, represented by Missouri; (2) the Southern district, represented by South Carolina, Georgia, Tennessee, and Kentucky; and (3) California and Nevada. The market for crude barite, likewise, can be separated into three principal areas: (1) The Atlantic Coast region, extending from Baltimore to New York; (2) the Middle Western market, including the area from St. Louis to Chicago; and (3) the Pacific Coast region, comprising plants at Modesto, Daggett, and Oakland, Calif.

The Pacific Coast market is largely self-contained, the imports of German barite and the shipments of crude barite from other parts of the United States being insignificant factors. Elsewhere in the United States, however, it will be noted that the market areas do not quite correspond with the boundaries of the producing localities; and in some measure it is for this reason that no single group of producers enjoys a monopoly. The Middle Western market is only partly supplied by the Missouri field, as the lithopone plants in this area, in particular, have received a portion of their supplies in recent years from producers in the Southern district. Along the Atlantic coast German imports of crude barite exert a powerful influence, and as a result the southern producers, being unable to sell all their output in the Eastern States, have been forced to seek an outlet for some of their product in the Middle West. Missouri producers, on the other hand, are shipping ground barite into the Eastern market; but in this field German competition, though confined to the seaboard area, is likewise severe.

The situation is further complicated because there are two grades of barite and because these two grades are interchangeable to only a limited extent. One grade, which is produced in Missouri and Germany, is soft and hence easily ground; while the other, which is produced in the Southern district, is hard and crystalline. The soft grade is more suitable for the manufacture of ground barite used as a filler in the paint, paper, and rubber industry, while the hard grade is used in the lithopone and barium chemical industries.

Prior to the World War the domestic mines furnished from 55 to 65 per cent of the crude barite consumed (80,000 tons in 1913) in the United States. Little, if any, crude barite was ground in the Atlantic Coast region, but ground barite produced in the Middle West was shipped to the Atlantic coast in competition with imported material which was dutiable under the tariff act of 1909 at $5.25 a long ton. It has been estimated that about 50 per cent of the ground barite manufactured in the Middle Western area was consumed in the Atlantic Coast market prior to the war; and this proportion probably still holds true today despite an increase in the duty under the tariff act of 1922 to $7.50 a ton. The Southern district has not yet become a factor in the ground-barite industry, although during the war it temporarily made small shipments for grinding. During the war several grinding plants were built along the Atlantic coast, so that for a time, German imports having been cut off, the markets for both hard and soft grades of barite were fairly evenly divided between the Southern district and Missouri. At present, however, German crude barite, being softer, has displaced Georgia barite as raw material for making ground barite in the eastern mills.

Before the war lithopone was the only product manufactured in this country on a large scale from crude barite by chemical process. The lithopone industry

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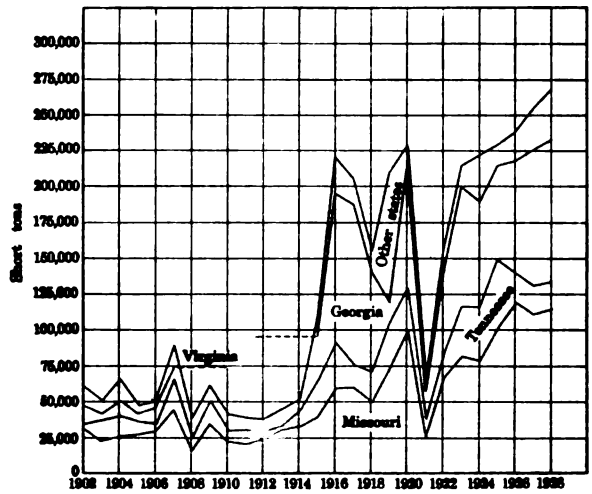

Figure 2. – Production of barite by states 1902-1928

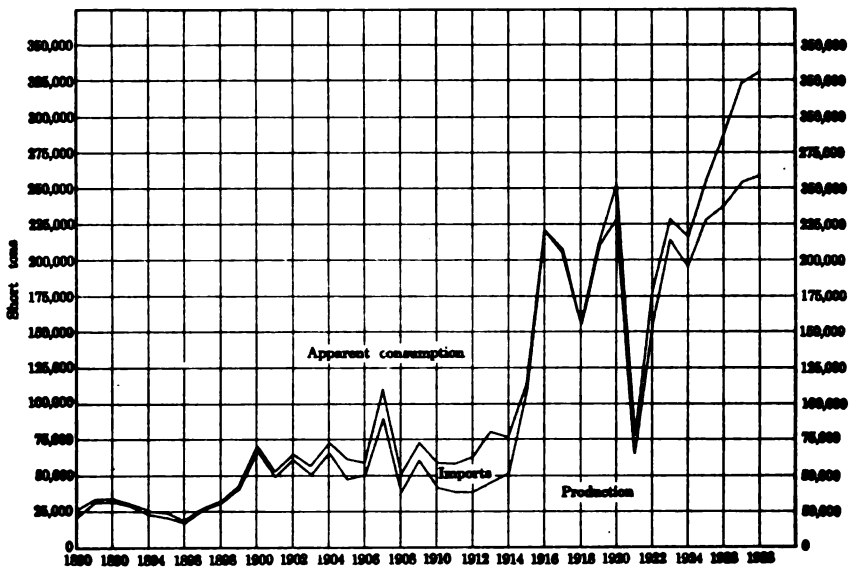

Figure 3. – Production, imports, and apparent consumption of crude barite in the United States, 1890-1928

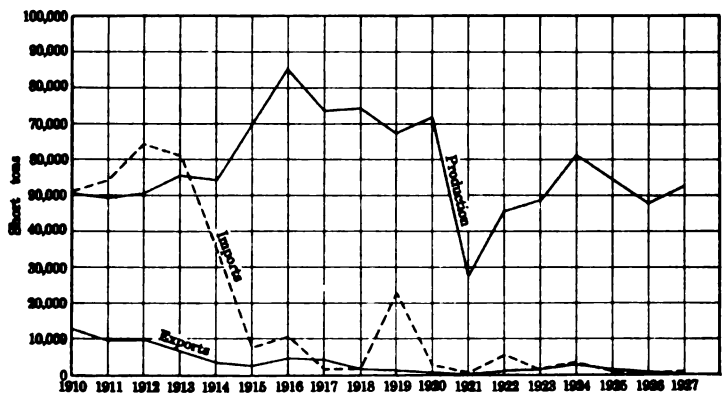

Figure 4. – Production, imports, and exports of crude barite, Great Britain, 1910-1927

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then confined to the Atlantic seaboard, depended mainly on imports from Germany, although it also consumed the output from the Southern district, which at that time was rather small. A limited amount of soft barite from the Missouri field also entered the lithopone industry.

During the war, barium chemical plants were built along the Atlantic seaboard; and in the absence of imports from Germany, the eastern market for crude barite - including that for the manufacture of ground barite, lithopone, and barium chemicals - was shared by the Southern district and by Missouri in practically equal proportions. Under war conditions the Southern output increased rapidly, with the result that from 1916 to 1919 Georgia produced even more crude barite than Missouri, which in other years has been the leading producing State. The Southern district was primarily developed, however, to supply the raw-material requirements of the lithopone and the newly developed barium chemical industries of the Eastern States. One of the results of the war, however, was the establishment of lithopone and barium chemical industries in the Missouri field; these newly developed industries can use the hard, crystalline barite quite as well as the soft barite produced locally, and certain plants, though situated in the geographical territory of the Missouri producers, have been making purchases from the Southern producers who, as a result of renewed German competition, have been unable to dispose of their augmented output in the East.

To a limited extent producers in both the Southern and Middle Western districts have been driven from the Atlantic Coast market, in so far as the lithopone and chemical industries are concerned, by German barite, which though darker in color (ranging from gray to black) is suitable for use in these industries. Under the tariff act of 1922, the duty on crude barite is $4 a long ton, but the German material is offered at eastern plants at lower prices than that from Georgia. Although German barite is not ordinarily shipped into the Middle Western district, it competes indirectly with Missouri barite for the reason that the southern producers, having been crowded out of the eastern market to some extent, are striving to sell more and more barite in the Middle West.

For the present the production of barite in the United States is limited only by the demand for it. California, Nevada, Georgia, Tennessee, and South Carolina, in particular, seem to contain large undeveloped deposits, and supplies from other domestic producing areas could probably be greatly increased if the market justified such expansion.

BARITE IN FOREIGN COUNTRIES

Both barite and witherite are produced in a number of foreign countries, but Germany, Italy, and Canada have the most important barite deposits and Great Britain the most important witherite deposits; these countries are practically the only ones whose products enter into world trade.

GERMANY

Germany has extensive resources of barite, and before the war was the leading producer of this mineral, a position now held by the United States. Vein deposits, in which the barite is often associated with other minerals, are of

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common occurrence. The more important of the ordinary vein deposits include those of the Thuringian Forest, the Black Forest, the Odenwald, Hesse, and the Bavarian Palatinate. Some of these yield white barite of first quality, while others yield a ferruginous product which is less valuable. The output at Nentershausen near Soutra in Hesse, and at Hergés-Vogtei in the Thuringian Forest, includes material of exceptional purity.

At Meggen, in Westphalia, there is a rather unusual type of deposit, having a bedded appearance, from which large amounts of dark-colored mineral, suitable for the manufacture of lithopone, have been obtained. A considerable part of the barite exported to the United States come from this deposit.

In the Siegen district of Westphalia, southeast of Cologne, operations at the Hartenrod deposit were started some 30 years ago. This deposit, which is of the vein type, showed at the outcrop a width of 25 feet, but it narrowed down to an average width of 10 feet. About 3 miles distant, at Wallenfels, a similar deposit is being worked by the same company operating the Hartenrod deposit, and the ore is sent to the mill at the latter place by aerial tramway.

The Hartenrod, or Bismarck mine, has reached a depth of 300 feet in a vertical shaft; the workings are also entered by an adit. The ore deposit consists of a single vertical vein of massive barite, much jointed and fissured, which is permeated with black stains of manganese dioxide on the joint planes. The barite itself ranges in color from clean white to yellow and rose. It is usually coarsely crystalline with a platy structure, and is of the soft easy-grinding type; the coarsest material usually exhibits the whitest color. The vein has been traced along the strike for a distance of over three-quarters of a mile.

The deposit itself and the method of mining are typical of the barite industry of Germany. Practice at the treatment plants likewise is typical of the methods followed elsewhere in Germany, and shows the care taken to ensure a high-grade product. Much hand labor is necessary at the concentrator in cobbing and picking the mill feed. Cheap labor, since it permits a visual selection of the material, is an important factor in Germany's success in the making of good barite products.

At the concentrator the ore is dumped on a grizzly with 4-inch openings and falls to a hopper with automatic feed. It then passes to a wash trommel furnished with a longitudinal spiral baffle and a 6-inch lip and punched with 2-inch holes at the discharge end. The oversize from this trommel goes to the cobbing and sorting bench where the waste is rejected and the following three products are separated: (1) Best-grade lump; (2) off-color lump; and (3) mixed fines. The off-color lump undergoes no further cleaning, but is ground separately. The best-grade lump goes to another wash trommel and is then dried on a steam-heated drying floor paved with iron plates. After drying about two hours it is fed to a ball mill fitted with a pneumatic elevator which lifts the fine barite to the buhrstones which effect the final grinding. Each buhrmill is operated in closed circuit with a pneumatic elevator and an air classifier. The air-floated product is ready for bagging, and the coarse discharge is returned to the buhrmills.

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The undersize from the first wash trommel, together with the mixed fines from the cobbing bench, go to vertical washing tanks and thence by gravity to washing and sizing trommels. All washing is performed with hot water from the condensers. The trommels make three sizes of product: (1) plus 1 inch; (2) 1 to 1/2 inch; and (3) minus 1/2 inch. The latter size is jigged to make a concentrate running 95 per cent $BaSO_4$ which is shipped as raw material for chemical uses, lithopone, etc. The intermediate trommel product is also jigged, and the concentrate is passed over a picking belt. The coarsest trommel product is passed direct to a picking belt.

From the picking belts, which are about 20 feet long, boys pick off both the clean white barite and the waste rock. The remainder is dried, ground, and air-floated, but in another system of ball mills and buhrs, to make an intermediate grade of product. This material, however, is dried in a rotary dryer through which a current of hot air is passed. No bleaching of the barite is practiced, reliance being placed entirely upon careful hand-picking to ensure a white product.

Production

Actual production data for crude barite in Germany are difficult to secure. Only the figures for Bavaria are reported regularly; those for Baden, Prussia, and Saxony are desultory. Table 8 shows the production of barite for the four German States, namely, Baden, Bavaria, Prussia, and Saxony for the years 1908 to 1927, inclusive.

Table 8.- Production of crude barite in Germany, 1908-1927[1]

(short tons)

Year	Baden	Bavaria	Prussia	Saxony	Total
1908	9,429	18,954	-	-	28,383
1909	16,740	19,753	-	-	36,493
1910	15,247	27,239	-	-	42,486
1911	16,550	28,918	-	-	45,468
1912	17,495	29,981	-	-	47,476
1913	18,127	2/ 29,973	-	-	48,100
1914	-	2/ 19,862	-	-	19,862
1915	-	2/ 7,874	-	-	7,874
1916	-	13,761	-	-	13,761
1917	-	11,242	-	-	11,242
1918	-	6,071	-	-	6,071
1919	-	9,722	-	-	9,722
1920	-	8,695	114,613	-	123,308
1921	-	25,837	94,050	-	119,887
1922	-	17,790	181,180	-	198,870
1923	-	22,013	107,151	-	129,164
1924	-	25,385	112,794	2,288	140,467
1925	-	23,674	166,715	1,067	191,456
1926	-	29,712	149,162	-	178,874
1927	-	22,085	170,629	-	192,714

1/ Figures for the years 1916-1919, inclusive, were taken from The Mineral Industry, vol.30, New York, 1921, pp. 827-828; figures for 1920-1927 were compiled for Mineral Resources of the United States.

2/ Figures for Bavaria for 1913-1915 were taken from The Mineral Industry of the British Empire, Imperial Mineral Resources Bureau, London.

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Within recent years, as may be seen from Table 8 (which no doubt is incomplete), Prussia is by far the principal source of crude barite, producing an average of about four-fifths of the total German output. Figures prior to 1920 are not available for Prussia, though it is estimated that they averaged between 75,000 and 100,000 tons annually.

The actual total production of crude barite in Germany is not known, as figutes are not available for each State, but it is estimated to be in the neighborhood of 250,000 short tons annually.

The production of crude barite in Bavaria has been fairly steady during the past six or seven years, averaging about 25,000 tons annually, or a trifle less than the output immediately before the war.

Production figures for Baden have not been available since 1913, in which year 18,127 short tons were produced. It has been estimated, however, that the production of crude barite in this State has shown a steady increase, and no doubt about 50,000 tons are now produced annually.

The production in Saxony, for which figures are available for only 1924 and 1925, has never exceeded 3,500 tons annually; however, the prospects of an increased production in the near future, should there be the necessary demand for barite, are very good, as this State has several vein deposits of good quality and quantity.

Exports

Though Germany produces both barite and witherite, her foreign trade in the latter product has never assumed a large volume. Figures of the foreign trade for either of these two minerals are not available for the war years (1914 to 1919) but the average exports of crude barite for the eight years after the war (1920-1928) is but slightly greater than the average for a similar period (1906-1913) prior to the war.

Great Britain and the United States are the best customers for German barite. For the eight-year period prior to the war (1906-1913), Great Britain imported on an average of 34,711 short tons annually from Germany, or 28 per cent of the total German exports. The United States purchased a little less than one-half of this amount, or an average of 16,421 tons or 13 per cent of a total average exports of 125,573 tons.

For the eight-year period following the war, Great Britain's share of German trade in crude barite amounted to an average of 25,652 tons, or 20 per cent of the total average exports from Germany of 126,548 tons. For this same period the United States imported an average of 27,157 tons, or 21 per cent of the total.

The exports of witherite from Germany during the eight-year period prior to the war, averaged 2,383 short tons as compared with the average of only 507 tons for the period following the war.

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As stated elsewhere, practically all of the crude barite exported by Germany to the United States is consumed in the lithopone and barium chemical industries situated along the Atlantic seaboard.

Tables 9 and 10 show the export trade of crude barite and witherite from Germany to the principal importing countries for the years 1906 to 1927 (the war years 1914 to 1919 are excluded).

Table 9.- German exports of witherite (barium carbonate), 1906-1927
(short tons)

Year	United States	Great Britain	Other countries	Total
1906	36	57	1,638	1,731
1907	15	57	1,540	1,612
1908	41	66	4,325	4,432
1909	129	123	2,654	2,906
1910	120	40	2,548	2,708
1911	254	88	1,273	1,615
1912	215	384	1,266	1,865
1913	91	443	1,261	1,795
1914) to 1919)	Not available	-	-	-
1920	-	2	560	562
1921	-	17	369	386
1922	309	220	445	974
1923	137	-	69	206
1924	50	-	245	295
1925	184	-	105	289
1926	87	-	205	292
1927	573	-	475	1,048

1/ Figures obtained from German Foreign Commerce, Trade by Articles volume.

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Table 10. - German exports of crude barite, 1906-1927 1/
(short tons)

Year	Great Britain	United States	Canada	Other countries	Total
1906	19,861	8,956	388	53,281	82,486
1907	23,982	21,539	1,328	75,704	122,553
1908	19,940	11,677	340	68,475	100,432
1909	25,514	11,289	457	62,559	99,819
1910	37,890	14,759	1,344	71,969	125,962
1911	46,736	10,485	1,218	83,073	141,512
1912	61,794	14,059	1,603	80,126	157,582
1913	41,973	38,603	1,497	92,162	174,235
1914 to 1919)	Not available	-	-	-	-
1920	16,909	18,967	-	65,837	101,713
1921	6,816	7,121	-	19,239	33,176
1922	27,498	21,962	188	70,278	119,926
1923	29,478	15,028	1,008	54,305	99,819
1924	27,253	10,909	201	34,597	72,960
1925	37,281	29,471	269	118,512	185,533
1926	28,599	45,932	654	101,955	177,140
1927	31,386	67,865	1,370	121,502	222,123

1/ Figures obtained from German Foreign Commerce, Trade by Articles volume.

GREAT BRITAIN

Barite and witherite are produced in numerous localities throughout England and Scotland, but only a few counties produce substantial tonnages.

In the north of England the more important producing counties are Northumberland, Durham, Cumberland, Westmoreland and Yorkshire. Northumberland, though it yields a little barite, is of special interest because it has always been the chief producer of witherite in Great Britain, and, in fact, in the world. The supply is strictly localized; the three mines which have been opened are situated near the junction of the North and South Tyne Rivers above Hexham, and are all on galena-bearing veins. Only one mine (Settlingstones) is now working, but it has been contended that if the others were deepened, thick limestone beds might be met with which carry good barite ore bodies.

At the Settlingstones mine the vein is almost vertical, and averages about 10 feet in width. The higher grades of witherite consist of slightly yellow or brownish white crystalline masses with a waxy luster, and yield from 95 to 100 per cent of barium carbonate. The vein is richest between the 480 and 700 foot levels, and it is mined only in this horizon.

The witherite is first hand-picked, and the cleanest and higher grade material placed om one side. Some of this is clean enough for market; the remainder is crushed to 1-1/8 inch and passed on to a set of jigs which at one operation sort the material into sizes of less than and more than one-fourth inch

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and separate out the waste. By this means raw material with about 60 to 70 per cent barium carbonate is concentrated to about 93 per cent $BaCO_3$ in the lump witherite and to about 83 to 84 per cent in the fines.

Mineral that contains about 40 per cent $BaCO_3$ is not treated by the above process, but is crushed to 1/4-inch mesh and concentrated in jigs to about 83 per cent $BaCO_3$.

This plant markets three grades of witherite, as follows: (1) Highest-grade hand-picked lump (93 to 100 per cent of barium carbonate); (2) second-grade lump (about 90 to 93 per cent $BaCO_3$); and (3) fines (79 to 84 per cent $BaCO_3$).

The Settlingstone mine was originally worked for lead, but witherite has been produced for many years. Between 1870 and 1880 about 1,500 to 3,000 tons was mined annually. During the next 30 years a steady average of about 4,000 tons was produced annually. The highest output was that for 1910, when nearly 10,000 tons was obtained. It is estimated that at the present rate of output there is proved ground available for 40 years' working. At present from 2,000 to 4,000 tons is produced annually.

The County of Durham is an important barite producer. The chief operating centers are in Upper Teesdale and near Durham itself (New Brancepeth). The Teesdale mines are remotely situated, the chief one, Cow Green, being 9 miles from the nearest railway. That it can be worked profitably under such conditions is evidence of the abundance and quality of the ore.

Little barite is now produced in Cumberland. The Lake District is rich in metalliferous ores, and the gangues frequently carry barite mixed with other minerals. If an efficient and relatively cheap method of separation could be found, production would undoubtedly increase.

Westmoreland is an active producer of barite. In the western part of the county, in the Lake District, the deposits are of slight commercial importance, but to the east, in the Pennine Hills, the veins are numerous and extensively worked. In spite of the amount of work already done, there appears to be large reserves, as many of the smaller veins are untouched, the present workings for the most part are still relatively shallow, and no sign of deterioration appears with depth.

Barite has been worked in Yorkshire for a number of years, although never on a large scale. At the Leinhead mines, which constitute the only productive property, the barite varies in quality. Some is colorless, or glassy, and some of it is iron-stained and has to be bleached.

The crude barite from the mine is separated by hand-picking into fairly pure or high-grade ore which is reserved for further treatment; and second-class ore, or barite much intermixed with impurities. The latter type is marketed as small lumps and is bought by lithopone manufacturers.

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The high-grade barite is raked under running water on a perforated table to remove impurities. The washed lump retained by the grating after light crushing is hand-picked to remove adhering rock and galena and then transferred to the bleaching vats. The washings which pass through the grating are jigged and ground to form an inferior quality of ground barite.

The higher "lump" quality is bleached with dilute sulphuric acid in lead lined wooden vessels into which steam is passed through perforated lead pipes. The capacity of the vat is about 6 tons. When the operation is complete the acid is drained off and the bleached mineral is withdrawn, washed until the last traces of acid are removed, and dried. The acid can frequently be used over again.

After bleaching the mineral is crushed in a stone mill and ground fine in buhrmills. The barite comes from the mills in a fine state of subdivision, and packed in bags and marketed. Barite has been commercially produced at this plant for a number of years. Prior to 1898 the annual output was only 400 or 500 tons, but since then it has often reached 2,000 tons.

Derbyshire is a small though regular producer of barite. In 1892 the output amounted to 2,705 tons, but during recent years it has declined to less than 300 tons annually.

Barite is found and worked to a limited extent in other parts of England notably Shropshire and Montgomeryshire, in northern, eastern, and southern Wales and in Devonshire.

In Scotland, barite appears to have been worked for a considerable time. The earliest official mention of the Scottish barite industry seems to be in the "Mineral Statistics of the United Kingdom" for 1853, when 600 tons were credited to the Glen Sannox mine in Arran. In 1856, 70 tons were produced in Kirkcudbrightshire. From 1862 to 1895 no barite appears in the official returns. After that date the statistics are for the Muirshiels mine, which is the only operating mine at present.

Table 11 shows the output for Scotland from 1853 to 1862, not including Muirshiels, for which there is no record during this period.

Table 11. - Barite output for Scotland from 1853-1862[1]

Year	Long tons	Short tons
1853	600	672
1854	550	616
1855	550	616
1856	550	616
1857	Not available	- - -
1858	550	616
1859	Not available	- - -
1860	550	616
1861	625	700
1862	730	818

1/ Not including Muirshiels.

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From the appearance of the mines and information available, it seems probable that work ceased both in Arran and Kirkcudbright about 60 to 70 years ago.

Table 12 shows the output of barite from the Muirshiels mine from 1895 to 1913:

Table 12.- Output of barite from Muirshiels mine 1895 to 1913

Year	Short tons
1895	672
1896	784
1897	1,120
1898	1,232
1899	1,038
1900	984
1901	1,198
1902	672
1903	777
1904	582
1905	982
1906	1,117
1907	1,008
1908	973
1909	1,144
1910	1,196
1911	1,254
1912	784
1913	749

Production

Although both barite and witherite are important nonmetallic minerals in Great Britain, production has been considerably below that of the United States.

Table 13 gives the production of barite and witherite in Great Britain from 1900 to 1927, inclusive.

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Table 13.- Production of barite and witherite in the United Kingdom, 1900-1927 1/

Year	Quantity, short tons	Value at mine	Price per ton
1900	32,991	$142,316	$4.31
1901	30,927	135,337	4.38
1902	26,441	109,078	4.13
1903	27,184	108,620	4.00
1904	29,486	120,071	4.07
1905	32,551	144,136	4.43
1906	40,034	171,700	4.29
1907	47,011	187,068	3.98
1908	43,621	171,403	3.93
1909	46,778	197,230	4.22
1910	50,027	213,683	4.27
1911	49,412	196,538	3.98
1912	50,822	191,886	3.78
1913	56,050	205,055	3.66
1914	54,802	211,722	3.86
1915	69,974	388,488	5.55
1916	85,158	620,435	7.29
1917	73,424	687,797	9.37
1918	74,323	2/ 1,060,171	14.26
1919	67,297	962,967	14.31
1920	71,848	1,005,007	13.99
1921	27,629	387,573	14.03
1922	45,863	)	
1923	48,717	)	
1924	61,339	)	
1925	54,523	) (3)	(3)
1926	47,908	)	
1927	52,475	)	

1/ From "Mines and Quarries," Part III, General Report with statistics by Chief Inspector of Mines, Home Office of Great Britain.
2/ Value for 1918 to 1921 calculated at $4.85 per pound sterling.
3/ Values not available after 1921.

Within recent years - that is, from 1919 to 1927 - the production of barium minerals has averaged 53,067 short tons annually. Of this amount, between 3,000 to 5,000 tons yearly is estimated to be witherite, all of which is produced by one mine, the Settlingstones mine, in Northumberland.

The production of barium minerals in Great Britain during the war (1914-1918) averaged 71,536 short tons, the largest output in the history of the industry.

In the period from 1900 to 1913, inclusive, the average output was 40,238 short tons, the low production coming in 1902 (26,441 short tons) and the high in 1913 (56,050 tons). The average annual value for this period was

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$163,867, or $4.10 per short ton. The low value for these years was in 1913, when the average price per ton was $3.66; the high point was reached in 1905, with an average value of $4.43 per ton.

During the war period the value of the output of crude barite in Great Britain advanced rapidly. In 1914 the total value was recorded at $211,722, or $3.86 per ton. In 1918 the value had risen to $1,060,171, or $14.26 per ton. The average value during these five years was $593,723, or $8.06 per ton.

Figures for the value of the British output of crude barite since 1921 are not available, but for the three years following the close of the war the value averaged $785,182, or $14.11 per ton. For subsequent years the value in Great Britain, as in other barite-producing countries no doubt, has followed the downward trend which has taken place. In 1927 it was probably $7 to $8 per short ton.

Imports and exports

While the amount of crude barite imported into Great Britain during recent years is not as large as before the war, Germany still holds the predominant position as a source of imports. The barite imported is the best white quality, hence it seems that England's home production of this grade falls somewhat short of domestic requirements.

Prior to the war Great Britain imported an annual average of 57,630 short tons of crude barite valued at $704,492, or $12.22 per ton (1910-1913, inclusive). Of this amount Germany furnished an average of 39,757 tons valued at $511,776, or 69 per cent of the total quantity, and 73 per cent of the total value.

During the war period, when Great Britain had placed crude barite on the contraband list, her imports averaged 11,377 tons valued at $206,618 for the five-year period 1914-1918, inclusive. The average value per ton rose to $18.16 ($4.85 to 1 pound sterling). During 1914 Germany shipped in 26,779 tons valued at $324,601, in 1915 only 46 tons valued at $863, and from then on until the close of the war her exports ceased.

For the period 1919 to 1927, inclusive, Great Britain imported an average of 4,624 tons valued at $171,353, or $37 per ton. Of this amount Germany furnished an average of 1,591 tons valued at $18,266, or $11.48 per ton. This represented 34 per cent of the quantity and only 11 per cent of the value of the total imports into Great Britain. In 1919 Germany shipped in 892 tons valued at $32,320. Her exports steadily rose until in 1922 they reached 5,239 tons valued at $38,776 (Table 14).

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The exports of crude barite from Great Britain, like the imports, have shown a decided falling off in recent years. Immediately before the war - that is, from 1910 to 1913, inclusive - Great Britain exported an average of 9,691 short tons valued at $144,363 annually ($4.85 to 1 pound sterling). The high year was 1910, when the exports amounted to 12,874 tons valued at $184,872, and the low year was 1913, when only 6,425 tons with a value of $97,262 was exported. The exports during the war period (1914 to 1918, inclusive) fell almost to one-third of the former average, or an annual average of 3,356 tons valued at $101,394 the high point in this period coming in 1916 with 4,733 tons valued at $146,504, and the low in 1918 with 1,757 tons valued at $80,791.

Since the war there has been a further decrease, as the average exports from 1919 to 1927, inclusive, amount to little over 1,027 short tons valued at $33,832. In 1921 the world-wide depression reduced the exports, (34 tons valued at $1,571,) to the lowest point in the history of the industry.

Prior to the war Austria-Hungary was England's best customer for crude barite, but none of the secession states have continued to import British barite.

The United States has never imported much crude barite, though it has purchased more or less witherite.

The feature which affects the foreign trade of Great Britain in crude barite in recent years is the deficiency in the amount of best-grade white barite produced in that country. The exports have divided until they now, except for a small amount of witherite, consist almost exclusively of off-color material, for which there is difficulty in securing a market of any appreciable size. On the other hand, imports have greatly declined, and they now consist mainly of high-grade materials.

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Table 14.- Imports of crude barite into Great Britain, 1910-1927 1/

(in short tons)

Year	Germany		Netherlands		Belgium		Spain		United States		Other countries		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1910	31,154	$436,907	3,409	$38,252	15,672	$166,796	-	-	-	-	641	$10,344	50,876	$652,299
1911	35,354	449,522	3,547	45,095	14,929	151,179	-	-	-	-	224	6,553	54,054	652,349
1912	47,410	601,225	2,843	34,333	13,958	144,472	-	-	-	-	201	3,968	64,412	783,998
1913	45,111	559,452	2,410	27,005	12,228	122,996	-	-	-	-	1,439	19,871	61,188	729,324
1914	26,779	324,601	1,329	14,361	7,020	69,612	-	-	-	-	252	5,019	35,380	413,593
1915	46	863	18	534	-	-	2,692	$57,380	2,550	$67,580	2,631	48,321	7,937	174,678
1916	-	-	-	-	-	-	4,682	130,150	3,418	115,634	2,243	61,658	10,343	307,442
1917	-	-	-	-	-	-	1,154	30,395	109	4,855	304	10,466	1,567	45,716
1918	-	-	-	-	-	-	1,215	63,874	443	27,786	-	-	1,658	91,660
1919	892	32,320	1,002	31,278	1,107	38,131	9,920	432,673	9,390	601,492	551	37,302	22,862	1,173,196
1920	394	16,058	-	-	428	11,645	1,325	58,462	382	24,444	453	22,863	2,982	133,472
1921	507	17,872	-	-	95	2,241	267	9,734	-	-	111	3,540	980	33,387
1922	5,239	38,776	-	-	62	868	215	4,040	-	-	4	155	5,520	43,839
1923	1,432	12,135	-	-	-	-	37	1,072	-	-	208	2,837	1,677	16,044
1924	3,062	26,433	-	-	-	-	-	-	-	-	221	4,369	3,283	30,802
1925	2,342	12,363	-	-	-	-	-	-	-	-	188	2,856	2,530	15,219
1926	278	4,802	-	-	-	-	-	-	-	-	510	7,580	788	12,382
1927	178	3,633	-	-	-	-	-	-	-	-	822	10,204	1,000	13,837

1/ From Accounts relating to Trade and Navigation of the United Kingdom (Annual), London.

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Table 15.- Exports of crude barite from Great Britain, 1910-1927 1/

(in short tons)

Year	Russia		Germany		France		United States		Other Countries		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1910	3,712	$42,971	6,789	$100,948	-	-	1,255	$21,010	1,118	$19,943	12,874	$184,872
1911	1,696	27,480	5,095	79,992	-	-	1,412	20,069	1,229	20,588	9,432	148,129
1912	1,873	33,498	5,479	77,950	-	-	908	12,639	1,673	23,115	9,933	147,202
1913	1,007	19,831	3,456	48,458	-	-	1,037	14,685	925	14,288	6,425	97,262
1914	440	7,813	900	13,609	-	-	702	9,927	1,295	23,015	3,337	54,364
1915	77	1,469	-	-	867	$21,680	1,032	19,517	772	18,968	2,748	61,634
1916	428	13,594	-	-	2,482	71,882	1,146	33,727	677	27,301	4,733	146,504
1917	122	3,453	-	-	2,594	108,354	762	23,130	729	28,741	4,207	163,678
1918	-	-	-	-	1,257	62,192	336	10,762	164	7,837	1,757	80,791
1919	2	92	-	-	1,169	70,229	56	2,250	133	11,276	1,360	83,847
1920	)										(363	16,917
1921	)										(34	1,571
1922	)										(1,262	39,052
1923	)										(1,593	33,378
1924	)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(3,096	64,195
1925	)										(1,830	34,741
1926	)										(1,196	26,161
1927	)										(133	4,627

1/ Accounts relating to Trade and Navigation of the United Kingdom (Annual), London.

2/ Figures not available.

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Consumption

Table 16 and Figure 4 show the apparent consumption of crude barite in Great Britain for the years 1910 to 1927, inclusive, as follows:

Table 16.- Apparent consumption of barite in Great Britain, 1910-1927 1/
(in short tons)

Year	Production	Imports	Exports	Apparent consumption
1910 2/	50,027	50,876	12,874	88,029
1911 2/	49,412	54,054	9,432	94,034
1912 2/	50,822	64,412	9,933	105,301
1913	56,050	61,188	6,425	110,813
1914	54,802	35,380	3,337	86,845
1915	69,974	7,937	2,748	75,163
1916	85,158	10,343	4,733	90,768
1917	73,424	1,567	4,207	70,784
1918	74,323	1,658	1,757	74,224
1919	67,297	22,862	1,360	88,799
1920	71,848	2,982	363	74,467
1921	27,629	980	34	28,575
1922	3/ 45,863	5,520	1,262	50,121
1923	3/ 48,717	1,677	1,593	48,801
1924	3/ 61,339	3,283	3,096	61,526
1925	54,523	2,530	1,830	55,223
1926	47,908	788	1,196	47,500
1927	52,475	1,000	133	53,342

1/ Figures from Mineral Industry of the British Empire and Foreign Countries, Imperial Mineral Resources Bureau, London.
2/ Figures for 1910, 1911, and 1912 from Tariff Information Survey of the U.S. Tariff Commission.
3/ Excluding production of the Irish Free State, for which figures are not available.

The consumption prior to the war, from 1910 to 1913, averaged 99,544 short tons; the high point was reached in 1913 with 110,813 tons, and the low point in 1910 with 88,029 tons. During the war years (1914 to 1918) the consumption fell to 79,557 tons, or 80 per cent of the average for the pre-war period, while for the post-war period (1919 to 1927) the annual average apparent consumption fell to 56,484 tons, or 71 per cent of the average war-period consumption, and only 57 per cent of the post-war period.

Economic considerations

The output of barium minerals (chiefly barite) in the United Kingdom increased steadily for many years up to 1913, when it reached 56,050 short tons; the imports of foreign barite in that year amounted to 61,188 tons, mainly from Germany and Belgium. During the war period the imports of this mineral decreased, until during 1917-1918 they had fallen to about 1,600 tons a year. In the same period some increase took place in the home production, which reached 85,158 short tons in 1916 but fell to 74,323 by 1918. During 1919 the importation of barite increased considerably, reaching 22,862 tons.

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The pre-war price of best white ground barite varied from 45s. to 60s. a ton ($10.93 to $14.58); that of second grade was about 30s. a ton ($7.29) and "off-color" barite was worth from 20s. to 25s. a ton ($4.86 to $6.07). During the war these prices were greatly exceeded, and the production, especially of the lower grade material, was increased. Although the actual figures are lacking, it would appear that the larger part of the home production consisted even then of "off-color" material, and that the imports were mainly of the best white ground barite.

According to a report of the British Barytes Producers' Association, an organization formed in 1916, many producers of "off-color" barite are at present unable to find a market for their product, as the home production of this grade of barite is more than sufficient for the requirements. Great Britain's production of the best white ground barite, however, is now short of consumption requirements. The association has advocated that for a term of years imports of this grade should be licensed up to the requirements of the consumers after the home production had been absorbed, coupled with restrictions on the prices charged by home producers. They also thought it necessary that the industry shoul be protected against an expected dumping of barite from Germany and importation at low prices due to the current rates of exchange.

Many of the German barite operations are situated near the Rhine, and before the war the low water freight rates from the Rhine to London, compared with the heavy railway rates from the British mines to many of the manufacturing districts, gave the German producers a decided advantage in the British markets. It is also alleged that the British producer is further handicapped in consequence of the lower inland freights charged in England on imported cargoes.

A difficulty arises in regard to the white ground barite in respect to the quality of the home product. The paint-makers, especially lithopone, have in general preferred the German material, but very little precise information is available as to the methods of grinding adopted in that country other than that the product may pass through as many as 12 buhr-stone mills before it is ready for shipment.

The British Barytes Producers' Association has been investigating the subject of grinding with the object of improving the grinding of the ore and the grading of the finished material. A system of grading by elutriation has been devised, and samples of German product tested by this system were markedly superior to the British product. Investigations are being made to find a better means of grinding than by buhrstones, and a combination of a wet grinding process with continuous elutriation is being tried.

ITALY

Production

Barite is produced in several districts in Italy and in Sardinia, among the more important of which are Carrara, Iglesias, Milano, and Trento; Padova and Torino produce smaller quantities. Tables 17 and 18 show the production of crude barite in Italy by districts for 1913, 1926, and 1927 and the total production of crude barite for the years 1910 to 1927, inclusive.

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Table 17.- Production of barite in Italy by districts, 1913, 1926, and 1927
(in short tons)

District	1913	1926	1927
Carrara	937	3,031	2,811
Iglesias(Sardinia)	441	2,513	2,675
Milano	12,346	15,983	19,952
Padova	551	1,009	110
Torino	-	441	331
Trento	-	12,125	7,937
	14,297	35,103	33,815

Table 18.- Production of barite in Italy, 1910-1927 1/
(in short tons)

Year	Quantity	Value 2/
1910	15,895	$ 58,740
1911	15,013	55,352
1912	14,793	55,073
1913	14,297	54,841
1914	14,297	54,841
1915	19,676	75,328
1916	23,865	97,378
1917	20,944	115,530
1918	16,474	221,043
1919	21,374	278,422
1920	16,953	453,068
1921	14,881	179,297
1922	23,479	278,692
1923	30,415	409,392
1924	43,616	623,641
1925	35,439	596,537
1926	35,103	570,000 3/
1927	33,815	445,579

1/ Revista del Servizio Minerario, Ministero di Agricoltura, Industria e Commercio (Annual), Rome.
2/ One lire = 19.3 cents.
3/ Estimated.

As may be seen from the above table, the production of barite in the Carrara district in 1927 amounted to 2,811 tons. Of this amount 248 tons came from the province of Lucca, 2,563 tons from Spezia. In the Iglesias district the total production, 2,675 tons, came from Cagliari, Sardinia. In the Milano district three provinces produced 19,952 tons - namely, Bergamo, 1,764 tons; Brescia, 1,102 tons; and Como, 17,086 tons. In the Padova district Vincenza produced the total output of 110 tons. In the Torino district Cuneo produced all of the output, or 331 tons; Trento produced 7,937 tons. In the Iglesias district the three mines of Serbarin, Barbusi, and Gonnesa produced 1,102 tons, which was all sent to the plant at Sant' Antioco e Gonnesa for grinding. The Campagnia Chimico Mineraria del Sulcis constructed a new grinding plant in this district at Palmas Suergiu.

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With the opening up of a new mine in the Province of Carrara by the Zuccarello della Societa Barium, located in the Cummune of Bardineto, production of barite in Carrara in the near future is expected to increase about 100 per cent.

In the Trento district a new plant was built in 1925 at Dargo, which will increase the amount of ground barite produced in that district. The production in the Province of Vicenza comes from two localities, near Torrebelvicino and near S. Omirico di Recoaro. There is a grinding mill located at this latter place.

Most of the crude barite produced in the Milano district is shipped to three plants in Brescia for grinding. These are located at Vestone, Mura, and at Ponte Caffaro.

The industry in Italy has grown rapidly during recent years. Prior to the war the production of crude barite never exceeded 18,000 tons annually, and the average for the years 1910 to 1913 was 14,999 short tons, having an average annual value of $56,076, or $3.74 per ton. During the war period (1914 to 1918) the average annual production amounted to 19,051 tons valued at $112,824, or $5.92 per ton. For the nine-year period following the war (1919-1927), the average annual production increased to 26,347 tons valued at $426,069, or $16.17 per ton.

Imports and exports

Italy has a considerable volume of foreign trade in barium minerals. The exports, formerly much smaller than the imports, now exceed them by a wide margin. The industry has grown rapidly since the war, and domestic production has not only kept pace with the increased consumption, but has provided a growing surplus for export.

Germany and France have been the chief sources of Italian imports of crude barite and have furnished about three-quarters of the total brought into the country. Prior to the war, when the imports greatly exceeded the exports, Germany was furnishing about 1,000 tons and France 800 to 900 tons yearly. During the war France took Germany's place as the chief source for this material. The exports of barite from these two countries to Italy after the war amounted to less than one-half of the exports for the pre-war period, and the total imports likewise showed a proportionate decrease.

Table 19 shows the imports of crude barite into Italy for the years 1910 to 1928, inclusive.

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Table 19.- Imports of crude barite into Italy, 1910-1928[1]

(in short tons)

Year	France	Germany	Great Britain	Other countries	Total Quantity	Total Value
1910	915	865	57	122	1,959	$ 27,429
1911	904	1,235	3	89	2,231	39,069
1912	816	1,259	12	102	2,189	46,000
1913	842	1,037	7	66	1,952	51,256
1914	627	847	-	79	1,553	54,372
1915	1,132	260	-	62	1,454	50,929
1916	1,237	-	47	257	1,541	67,449
1917	520	-	365	351	1,236	54,112
1918	195	45	154	779	1,173	82,133
1919	630	12	-	184	876	69,072
1920	741	627	30	305	1,703	238,224
1921	(2)	(2)	(2)	(2)	658	115,803
1922					1,043	242,847
1923	276	548	46	65	935	188,752
1924	148	412	139	214	913	179,984
1925	427	258	56	108	849	151,453
1926	(2)	(2)	(2)	(2)	1,192	216,964
1927					811	192,997
1928					1,048	166,909

1 Statistica di Importazione e di Esportazione (Annual), Rome.
2 Data not available.

Whereas prior to the war the total exports never exceeded 450 tons annually, the post-war period shows total exports in excess of 7,000 tons.

France and Great Britain form the chief markets for Italian barite, the former taking as high as 2,900 tons (1924) and Great Britain 1400 tons (1920). United States is a small purchaser of Italian crude barite; its imports, never exceeding 1,000 tons in any one year, consist of the best grade which yields a pure white product when ground (Table 20).

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Table 20.- Exports of crude barite from Italy, 1910-1928[1]
(in short tons)

Year	France	Germany	Great Britain	United States	Other countries	Total Quantity	Total Value
1910	-	-	10	-	155	165	$2,321
1911	77	18	3	-	291	389	680
1912	212	-	-	-	208	420	7,348
1913	222	-	1	-	35	258	3,618
1914	77	-	-	-	154	231	3,249
1915	159	-	1,861	99	1,505	3,624	50,764
1916	472	-	1,695	-	870	3,037	42,536
1917	1,033	-	193	-	1	1,227	17,179
1918	577	-	-	-	-	577	10,092
1919	2,082	-	93	-	4	2,179	76,301
1920	2,349	-	1,445	180	764	4,738	373,316
1921)	(2)	(2)	(2)	(2)	(2)	(412	26,567
1922)						(596	47,787
1923	2,347	-	157	362	452	3,318	247,912
1924	2,946	-	923	343	1,668	5,880	458,989
1925	2,579	-	1,080	972	1,844	6,475	567,586
1926)						(7,801	696,552
1927)	(2)	(2)	(2)	(2)	(2)	(3,522	314,275
1928)						(5,190	420,111

1 Statistica di Importazione e di Esportazione (Annual) Rome.
2 Data not available.

Consumption

Table 21, following, shows the apparent consumption of crude barite in Italy for the years 1900 to 1927, inclusive. It has been estimated in recent years that about 40 per cent of the barite produced was exported to France, England, the United States, and Japan. Of the remainder, 10 per cent is used in the barium chemical industry, 20 to 25 per cent in the manufacture of heavy paper such as Bristol board, 12 to 15 per cent as a filler in paints, 5 per cent in the rubber industry, and from 1 to 2 per cent in the manufacture of lithopone[10]. Upon this basis the production in 1927 of 33,815 tons would be divided as follows: Exports, 13,426 tons; chemical industry, 3,380 tons; paper industry, 6,760 to 8,450 tons; for paint filler, 4,050 to 5,070 tons; and for the manufacture of lithopone, 338 to 676 tons annually.

10 Revista del Servizio Minerario, Ministero di Agricoltura, Industria e Commercio (Annual), Rome.

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Table 21.- Apparent consumption of barite in Italy, 1900-1927
(in short tons)

Year	Production	Imports	Exports	Apparent consumption
1900	15,436	947	44	16,339
1901	14,600	909	35	15,474
1902	14,600	1,290	100	15,790
1903	13,691	1,211	39	14,863
1904	13,547	2,067	77	15,537
1905	13,966	1,592	179	15,379
1906	13,250	1,543	162	14,631
1907	17,341	1,698	168	18,871
1908	17,011	1,679	798	17,892
1909	17,901	2,308	138	20,071
1910	15,895	1,959	165	17,689
1911	15,013	2,231	389	16,855
1912	14,793	2,189	420	16,562
1913	14,297	1,952	258	15,991
1914	14,297	1,553	231	15,619
1915	19,676	1,454	3,624	17,506
1916	23,865	1,541	3,037	22,369
1917	20,944	1,236	1,227	20,953
1918	16,474	1,173	577	17,070
1919	21,374	876	2,179	20,071
1920	16,953	1,703	4,738	13,918
1921	14,831	658	412	15,127
1922	23,479	1,043	596	23,926
1923	30,415	935	3,318	28,032
1924	43,616	913	5,880	38,649
1925	35,489	849	6,475	29,863
1926	35,103	1,192	7,801	28,494
1927	33,815	811	3,522	31,104

According to the above table the apparent consumption of crude barite in Italy prior to the war never exceeded 21,000 tons annually. For this period (1900 to 1913) the average annual production was 15,096 short tons; the average imports were 1,683 tons, and the average exports were 212 tons, making an average apparent consumption of 16,567 short tons. Incidentally, during this period the imports greatly exceeded the exports of crude barite.

The relative figures for the war-period (1914-1918) average as follows: Production, 19,051 tons; imports, 1,391 tons; and exports, 1,739 tons; thus the average annual apparent consumption is 18,703 tons, an increase of 2,136 tons, or 13 per cent over the pre-war period.

The corresponding figures for the post-war period (1919-1927) are as follows: Production, 27,349 tons; imports, 997 tons; and exports, 3,660 tons, resulting in an average apparent consumption of 24,686 tons, an increase of 5,983 tons, or 31 per cent over the war period, and 8,119 tons, or 49 per cent over the pre-war period.

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CANADA

The bulk of the barite produced in Canada, to date, has come from Nova Scotia.

The earliest recorded production of this mineral in Canada was from deposits at Five Islands (Colchester County) and Brookfield (Hants County), Nova Scotia. These deposits were first worked between 1865 and 1870, and together yielded about 5,000 tons of barite; but very little mining has been conducted there since 1880.

In 1869 the silver-bearing veins in Thunder Bay district, Ontario, were discovered, and certain of the leads - notably that on McKellar Island - proved to carry a large amount of barite. The McKellar Island deposit was worked for barite for several years and appears to have yielded several thousand tons of ore. The last work conducted there was in 1894.

In 1894 development of the extensive deposits on the east side of Lake Ainslie, Cape Breton Island, Nova Scotia, was commenced, and this district since 1904 has furnished practically the entire output of Canadian barite. The total production from this area, to date, may be placed at about 20,000 tons. From 1900 to 1903 mining was conducted at Cap Rouge, North Cheticamp district, about 35 miles north of the Lake Ainslie deposits, and shipments aggregating 2,500 tons were reported.

Scattered deposits of barite, most of them small and of only minor importance, have been worked at various times during the past 35 years in southeastern Ontario and in Quebec within a radius of about 100 miles of Ottawa. The total amount of ore secured from these deposits was small, and few of them even attained the status of shippers.

In more recent years, since 1910, attention has been drawn to the existence of large bodies of barite in northern Ontario. The first deposit to be exploited was situated in Langmuir Township in the Porcupine district, and later other occurrences were found in the Elk Lake district and Matachewan areas. In 1917 a large vein was discovered in Penhorwood Township, 150 miles west of Sudbury. Further development in these localities is prohibited by the lack of transportation facilities.

Production

Table 22 shows the annual production of barite in Canada from 1885 to 1928, inclusive. Practically the entire production has come from Nova Scotia, except for 60 tons valued at $1,020, produced and shipped from Ontario in 1918.

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Table 22.- Production of crude barite in Canada, 1885-1928[1/]
(in short tons)

Year	Quantity	Value
1885	300	$1,500
1886	3,864	19,270
1887	400	2,400
1888	1,100	3,850
1889	-	-
1890	1,842	7,543
1891	-	-
1892	315	1,260
1893	-	-
1894	1,081	2,830
1895	-	-
1896	145	715
1897	571	3,060
1898	1,125	5,533
1899	720	4,402
1900	1,337	7,605
1901	653	3,842
1902	1,096	3,957
1903	1,163	3,931
1904	1,382	3,702
1905	3,360	7,500
1906	4,000	12,000
1907	1,344	3,000
1908	4,312	19,021
1909	179	1,120
1910	-	-
1911	50	400
1912	464	5,104
1913	641	5,410
1914	612	6,169
1915	550	6,875
1916	1,368	19,393
1917	3,490	54,027
1918	640	10,165
1919	468	8,154
1920	751	22,983
1921	270	9,567
1922	289	9,537
1923	409	8,548
1924	151	3,308
1925	95	2,259
1926	100	2,307
1927	56	1,262
1928	127	2,847

1/ Mineral Production of Canada (Annual), Ottawa.

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It will be noted that the barite mining industry has been subject to periodic rises and declines, and that no consistent growth has been shown. Several grinding mills have been operated at different times, three in Nova Scotia, one in Montreal, and one in northern Ontario. Only two of these mills, namely that of Barytes, Ltd., at Scotsville, Nova Scotia, and that of Premier Langmuir Mines, Ltd., in Langmuir Township, northern Ontario, were equipped with concentrating machinery; and the Scotsville mill is the only one where bleaching of ground barite has been practiced. The only mill which is in operation at present is that of Messrs. Brandram-Henderson, at Halifax, N. S., where Lake Ainslie ore is ground to supply the company's paint works at Halifax.

One reason for the failure to establish a barite industry in Canada would appear to be insufficient attention to the requirements of the trade; the result has been that the ground barite offered - either on account of its not being ground fine enough, or because of its being off-color, or contaminated by mineral impurities - has not been able to meet market specifications. The greater hardness of most Canadian barite, as compared with the soft Missouri ore, is a point that does not appear to have received proper recognition. Whether Canadian barite can be substituted satisfactorily for the Missouri material in the Canadian ground barite market may be considered questionable.

In any attempt to establish a ground barite industry in Canada, a prime requisite is that closer attention shall be paid to the grinding of the ore and the sizing of the ground barite than has, in most cases, heretofore been given.

Imports and exports

The foreign trade figures indicate the weak condition of the Canadian barite-producing industry. Imports are increasing, while exports have apparently ceased. Prior to April, 1919, Canadian foreign trade statistics did not separately classify the import data for crude barite. During the period for which statistics are available (1919-1928) the total imports have never exceeded 3,000 tons annually the average being 2,493 tons valued at $53,147, or $21.87 per ton (Table 23).

The exports of crude barite which are shown in Table 24 declined during the war, and since that date none has been shipped out of the country. Prior to the war the exports never exceeded 1,800 tons, valued at approximately $14,000, or about $8 per ton.

Table 23.- Imports of crude barite into Canada, 1919-1928 1/

(In short tons)

Year	Quantity	Value
1919	1,585	$34,441 2/
1920	2,998	74,314
1921	1,439	40,374
1922	2,954	64,186
1923	2,420	53,670
1924	2,323	48,693
1925	2,433	50,566
1926	2,422	48,011
1927	2,841	58,504
1928	2,878	58,710

1/ From Mineral Production of Canada (Annual), Ottawa.
2/ Not separately classified prior to April, 1919.

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Table 24.- Exports of crude barite from Canada, 1901-1915[1/]
(in short tons)

Year	Quantity	Value
1901	10	$3,820
1902	-	-
1903	20	363
1904	654	5,178
1905	1,724	14,343
1906	68	6,750
1907	28	2,750
1908	175	13,690
1909	-	-
1910	-	150
1911	-	-
1912	3	114
1913	None	-
1914	None	-
1915	None	-

1/ From Mineral Production of Canada (Annual), Ottawa.

PUBLICATIONS CONSULTED

The author has drawn freely upon the following publications for information concerning the geology, description of deposits, and general information pertaining to the barite industry in this country and abroad:

Special Reports on the Mineral Resources of Great Britain: Barytes and Witherite. Memoirs of the Geological Survey, London, 1915, pp. 1-93.

W. M. Weigle. The Barite Industry in Missouri. Tech. Pub. 201, Am. Insti. Min. and Met. Eng. New York, 1929, pp. 1-26.

Revista del Servizio Minerario, Ministero di Agricoltura, Industria e Commercio (Annual), Rome, Italy.

U. S. Tariff Commission. Barytes, Barium Chemicals and Lithopone. Tariff Information Survey, 1921, pp. 9-37.

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